Energy, Mines and Resources Canada | Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

ISO/TC 183/WG 4A - DETERMINATION OF COPPER IN COPPER CONCENTRATES BY ELECTROGRAVIMETRIC METHOD STATISTICAL EVALUATION OF INTERNATIONAL TEST DATA 1984-1986

R. Sutarno and W.S. Bowman
Extractive Metallurgy Laboratory

February 1986

(For submission to the Convenor of ISO/TC 183/WG 4A, to the Secretariat of ISO/TC 183 and for presentation at the ISO/TC 183 meeting to be held in Sydney, Australia, 1986-04-27 to 1986-05-03)

Project: 3.0.6.9.02
Analytical Methodology

This document is an unedited information report prepared primarily for discussion and internal operation purposes. It does not represent a final expression of the opinion of the Canada Centre for Mineral and Energy Technology (CANMET)

Ce document est un rapport [illegible] rédigé principalement [illegible] de documentation [illegible] représenter [illegible] l'opinion du Centre canadien de la technologie des minéraux et de l'énergie (CANMET)

70 pp

MINERAL SCIENCES LABORATORIES
DIVISION REPORT MSL 86-30 (IR)

MICROMEDIA

APR 23 1988

ISO/TC 183/WG 4A - DETERMINATION OF COPPER IN COPPER CONCENTRATES BY ELECTROGRAVIMETRIC METHOD STATISTICAL EVALUATION OF INTERNATIONAL TEST DATA 1984-1986

by

R. Sutarno* and W.S. Bowman**

ABSTRACT

The analytical data resulting from the international test on the determination of copper in copper concentrates by electrogravimetric method using (1) sulfide separation and (2) hydroxide separation techniques conducted by ISO/TC 183/WG 4A during the period of 1984-1986 have been statistically evaluated. Based on these analytical results, the precision of the analytical method can be expressed in terms oF the Cu concentration level by the following equation:

Sulfide	Hydroxide
r = 0.0009x + 0.1592	r = 0.0020x + 0.0456
P = 0.0093x + 0.C838	P = 0.0141x - 0.1371
sr = 0.0003x + 0.0563	sr = 0.0007x + 0.0161
sL = 0.0034x + 0.0174	sL = 0.0050x - 0.0523

where x is the Cu concentration in the sample, r is the repeatability, P is the permissible tolerance, sr is the within-laboratory standard deviation and sL is the between-laboratories standard deviation all expressed in percent. Five samples containing Cu ranging from 20 to 50 percent were used in this international test. Twenty laboratories participated in this test.

---

*Research Scientist and **Technologist, Physical Chemistry Section, Extractive Metallurgy Laboratory, Mineral Sciences Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa, Ontario K1A 0G1.

ISO/CT 183/GT 4A - DÉTERMINATION DE LA TENEUR EN CUIVRE DE CONCENTRÉS DE CUIVRE PAR LA MÉTHODE ÉLECTROGRAVIMÉTRIQUE ÉVALUATION STATISTIQUE DES DONNÉES D'UN ESSAI INTERNATIONAL (1984-1986)

par

R. Sutarno* et W.S. Bowman**

RÉSUMÉ

Les données analytiques qui ont résulté de l'essai international effectué par le Groupe de travail 4A du Comité technique 183 de l'Organisation internationale de normalisation (ISO) dans la période allant de 1984 à 1986 en vue de déterminer la teneur en cuivre de concentrés de cuivre par la méthode électrogravimétrique en utilisant les techniques 1) de séparation par sulfures et 2) de séparation par hydroxyde ont fait l'objet d'une évaluation statistique. Selon les résultats analytiques, l'estimation de la précision de la méthode peut être exprimée en terme du niveau de concentration de Cu au moyen de la formule suivante:

Sulfures	Hydroxyde
$r = 0{,}0009x + 0{,}1592$	$r = 0{,}0020x + 0{,}0456$
$P = 0{,}0093x + 0{,}0838$	$P = 0{,}0141x - 0{,}1371$
$sr = 0{,}0003x + 0{,}0563$	$sr = 0{,}0007x + 0{,}0161$
$sL = 0{,}0034x + 0{,}0174$	$sL = 0{,}0050x - 0{,}0523$

où X représente la concentration en Cu de l'échantillon, r, la répétabilité, P, l'écart admissible, sr, l'écart-type de chaque laboratoire et sL, l'écart-type de l'ensemble des laboratoires, le tout exprimé en pourcentage. Cinq échantillons ayant une teneur en Cu variant de 20 à 50 % ont été utilisés aux fins de l'essai. Vingt laboratoires ont participé à cet essai.

---

*Scientifique de la recherche et **Technologue, Section de la chimie physique, Laboratoire de métallurgie extractive, Laboratoires des sciences minérales, CANMET, Énergie, Mines et Ressources Canada, Ottawa (Ontario) K1A 0G1

INTRODUCTION

The analytical data were collected by the convenor of ISO/TC 183/WG 4A (ISO Technical Committee 183 - Copper, Lead and Zinc Ores and Concentrates, Working Group 4A - Copper, Copper Concentrates by Electrogravimetric Methods) from an international test conducted during the period 1984-1986. Five samples of concentrates with copper contents ranging from 20 to 50 percent were used. Two variations of the method: (1) sulfide separation and (2) hydroxide separation techniques were investigated. Twenty laboratories provided analytical data; each analysed the sample in triplicate.

The purpose of this statistical evaluation is to provide the working group with the preliminary estimates of the precision in the form of repeatability, permissible tolerance, within-laboratory and between-laboratories standard deviations.

PRINCIPLE OF ANALYTICAL METHOD

1. Sulfide Separation

Samples of sulfidic copper concentrates are attacked with nitric acid and fumed with sulfuric acid. The following steps are: precipitation of copper sulfide with sodium thiosulfate, dissolving of the precipitate with nitric acid/sulfuric acid, separation of silver as silver chloride and electrogravimetric determination of copper in the presence of nitric acid, sulfuric acid, peroxidisulfate and traces of chloride. Under this condition there is no coprecipitation of small amounts of molybdenum. Traces of copper in the filtrate of the copper sulfide precipitation and in the electrolyte after copper precipitation are determined by flame atomic absorption and added to the result.

If the concentrates contain considerable amounts of elements which may influence the results other separation is needed:

(a) Greater than 0.01% Bi: double precipitation with ammonia.

(b) Greater than 0.01% each of As, Sb, Sn, Se: fuming with hydrobromic acid.

(c) Greater than 0.2% each of Mo, W, Hg,, Te (As, Sb, Sn, Se): extraction of the sulfide precipitate with sodium sulfide.

In addition, a blank determination should be carried out and in the case of sodium sulfide extraction, no fuming with hydrobromic acid is necessary.

2. Hydroxide Separation

Decompose the sample with nitric and sulfuric acids and evaporate to white sulfuric acid fumes. After dissolving the soluble salts with water, add ammonia water to coprecipitate arsenic, antimony and the like together with ferric hydroxide, and filter. Heat and evaporate the filtrate adjusting its volume, add nitric acid and sulfuric acid, and electrolyze with low current density. After completion of the electrodeposition, wash the cathode with water and ethanol, dry and measure the amount of electrodeposited copper and determine the remaining copper in electrolyte by atomic absorption.

At the same time dissolve the ferric hydroxide precipitate with hydrochloric acid, dilute to a specific volume and determine the amount of copper absorbed in the precipitate by atomic absorption and added to the amount of the electrodeposited copper. In addition, a blank determination should be carried out.

STATISTICAL EVALUATION

The analytical data collected were statistically evaluated by the procedure described in document ISO/TC 102/TCR 5 (3). Because each participating laboratory analysed only one bottle of each sample, as required by WG stage A, the two-way analysis of variance (ANOVA) part of the procedure was by-passed. No confirmation of sample homogeneity was made; thus the between-laboratories variance may include, if any, the between-bottles variation of the sample. This procedure is illustrated schematically in Fig. 1.

The raw data and the detail calculation are presented in Appendix A. They are summarized in Table 1 and 2. The raw data are also plotted in Fig. 2. The boxed points in these figures signify that the data were suspected to be outliers and were excluded from the estimation of the sample means and precisions. The letter C on the boxed points signifies that the

data were suspected to be outliers due to poor precision (Cochran's test) and the letter D due to the deviation from the sample means (Dixon's test).

The precisions estimated (sr, sL, r and P) are plotted against their corresponding sample means in Fig. 3, and the regression equations of these precisions against sample means were computed and presented in Table 1. Table 2 lists the suspected outliers. Table 3 shows comparison between sample grand means and precisions obtained by the results of sulfide and hyroxide separation techniques. Table 4 and 5 show the statistical test of these comparisons.

OBSERVATIONS

An ideal standard analytical method is an analytical method that can be applied by any qualified analyst with proper equipment and reagents with equal precision and accuracy. This implies that the better the method is standardized the smaller is the sL/sr ratio and the fewer the number of outliers. The magnitude of within-laboratory standard deviation itself depends on the state of the art of the method. Experience from another Technical Committee dealing with mineral analyses (iron ores) shows that for a good method, the average sL/sr ratio is found to be about 2. Table 1 shows that the magnitude of the within-laboratory precision seems to be reasonable. Using sL/sr ratio of 2 as a bench mark, the observed sL/sr ratios for both techniques are acceptable with the exception of sample 85-9. Figure 3 shows that for the level under investigation (20 - 50% Cu), the within-laboatory precision is virtually independent of level. The average sr for the sulfide separation technique is found to be 0.066% Cu and for hydroxide separation technique 0.039% Cu. Table 4 shows that this difference is statistically significant. Thus the hydroxide separation technique seems to produce results with slightly better precision. On the other hand, Table 2 shows that there are more outliers than the sulfide technique. Some laboratories namely CND 3, CND 4 and GER 5 seem to have difficulty applying the hydroxide technique. Table 5 shows that, with the exception of sample 85-7, the difference between the grand means obtained by both methods are statistically insignificant.

REFERENCES

1. "Copper concentrates - Determination of copper content; Electrogravimetric method with surface separation"; ISO/TC 183/WG 4A-1.

2. "Copper concentrates - Determination of copper content; Electrogravimetric method with ammonia-separation"; ISO/TC 183/WG 4A-2.

3. "Procedure for statistical evaluation of analytical data resulting from international tests"; ISO/TC 102/TCR 5, 1985-06-11.

4. "ISO/TC 69/SC 6/WG 1 - Precision of test methods - Determination of repeatability and reproducibility by interlaboratory tests - Comparison of alternative test methods (Third Draft)"; R. Sutarno and W.S. Bowman, Division Report MRP/MSL 85-18 (OP&J), CANMET, Energy, Mines and Resources Canada, November 1985.

Abbreviations Used in this Report

sr = SIGMA-R - within laboratory standard deviation

sL = SIGMA-L - between laboratories standard deviation

r* = R - repeatability

= 2.83 sr

p** = permissible tolerance between laboratories

= $2.83\ (sL^2 + sr^2/2)^{1/2}$

* Repeatability, r, is the value below which the absolute difference between two independent single test (analysis) results produced by a laboratory on identical material using the same equipment within a short interval of time, using the standardized test method, may be expected to be with a 95% probability.

** Permissible tolerance between laboratories, P, is the value below which the absolute difference between two means of duplicate test results on identical material obtained by operators of different laboratories using the standardized test method, may be expected to lie with a 95% probability.

KO - total number of participating laboratories

K - number of sets of laboratory results used for ANOVA

NO - total number of analytical results

N - No. of analytical results used for ANOVA

AU = Australia
BR = Brazil
CHN = China
CND = Canada
CZ = Czechoslovakia
FR = France
GER = Germany
HGR = Hungary
IND = India
IT = Italy
JP = Japan
NL = Netherlands
NZ = New Zealand
PHL = Philippines
PNG = Papua New Guinea
POL = Poland
SA = South Africa
SW = Sweden
UK = United Kingdom
USA = United States
USS = Soviet Union
YU = Yugoslavia

Table 1.Sul

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE

SUMMARY OF PRECISIONS FOR ALL SAMPLES

ELEMENT	SAMPLE	KO	K	NO	N	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L	SIGMA-L/SIGMA-R
COPPER	85-6	18	17	54	51	19.8511	.1486	.2616	.05251	.08466	1.61
COPPER	85-7	18	18	54	54	24.2123	.2355	.4002	.08320	.12861	1.55
COPPER	85-8	18	17	53	50	33.3634	.1720	.3105	.06077	.10096	1.66
COPPER	85-9	18	17	54	51	50.4056	.2070	.5858	.07314	.20043	2.74
COPPER	85-10A	14	14	42	42	28.6811	.1706	.3135	.06029	.10224	1.70

THE REGRESSION EQUATIONS ARE:

				CORR. COEFF.
R	=	.0009 X +	.1592	.3021
P	=	.0093 X +	.0838	.8540
SIGMA-R	=	.0003 X +	.0563	.3022
SIGMA-L	=	.0034 X +	.0174	.8716

Table 1.H

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE

SUMMARY OF PRECISIONS FOR ALL SAMPLES

ELEMENT	SAMPLE	KO	K	NO	N	MEAN(X)	REPEATABILITY	PERMISSIBLE TOLERANCE	SIGMA-R	SIGMA-L	SIGMA-L/SIGMA-R
COPPER	85-6	20	15	59	44	19.8896	.0818	.2167	.02891	.07381	2.55
COPPER	85-7	20	15	60	45	24.3296	.0809	.1800	.02860	.06030	2.11
COPPER	85-8	20	17	60	51	33.3972	.1519	.3201	.05367	.10654	1.99
COPPER	85-9	20	19	60	57	50.5303	.1352	.6048	.04777	.21104	4.42
COPPER	85-10A	16	15	48	45	28.7159	.0958	.2118	.03384	.07092	2.10

THE REGRESSION EQUATIONS ARE:

					CORR. COEFF.
R	=	.0020 X	+	.0456	.7370
P	=	.0141 X	+	-.1371	.9572
SIGMA-R	=	.0007 X	+	.0161	.7370
SIGMA-L	=	.0050 X	+	-.0523	.9538

Table 2.Sul

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE

LIST OF OUTLIERS

ELEMENT	SAMPLE	COCHRAN (PRECISION)	DIXON (ACCURACY)	LAB HAS ONLY ONE RESULT	INDIVIDUAL OUTLYING RESULT (DIXON)
COPPER	85-6	GER 3	-	-	-
COPPER	85-7	-	-	-	-
COPPER	85-8	CND 3	-	-	-
COPPER	85-9	GER 3	-	-	-
COPPER	85-10A	-	-	-	-

Table 2.H

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE

LIST OF OUTLIERS

ELEMENT	SAMPLE	COCHRAN (PRECISION)	DIXON (ACCURACY)	LAB HAS ONLY ONE RESULT	INDIVIDUAL OUTLYING RESULT (DIXON)
COPPER	85-6	CND 3	CND 4	-	-
		CND 4	GER 5	-	-
		GER 4	-	-	-
		GER 5	-	-	-
		UK 1	-	-	-
COPPER	85-7	AU 1	CND 4	-	-
		GER 5	-	-	-
		JP 2	-	-	-
		UK 1	-	-	-
COPPER	85-8	CND 3	-	-	-
		CND 4	-	-	-
		GER 4	-	-	-
COPPER	85-9	CND 3	-	-	-
COPPER	85-10A	CND 4	CND 4	-	-

Table 3.

ISO/TC 183/WG 4A-Copper in Copper Concentrates - Electrogravemetric Method
Comparison of sample grand means and precision
obtained by sulfide and hydroxide separation techniques.

Sample	X,%			r,%			P,%			sr,%			sL,%		
No	Sul.	Hyd.	S/H	Sul.	Hyd.	S/H	Sul.	Hyd.	S/H	Sul.	Hyd.	S/H	Sul.	Hyd.	S/H
85-6	19.851	19.890	1.00	0.149	0.082	1.82	0.282	0.217	1.21	0.053	0.029	1.83	0.085	0.074	1.15
85-7	24.212	24.330	0.99	0.235	0.081	2.90	0.400	0.180	2.22	0.083	0.029	2.86	0.129	0.080	2.15
85-8	33.383	33.387	1.00	0.172	0.152	1.13	0.311	0.320	0.97	0.061	0.054	1.13	0.101	0.107	0.94
85-9	50.408	50.530	1.00	0.207	0.135	1.53	0.588	0.605	0.97	0.073	0.048	1.52	0.200	0.211	0.95
85-10A	28.681	28.716	1.00	0.171	0.096	1.78	0.313	0.212	1.48	0.060	0.034	1.76	0.102	0.071	1.44

T.5

X - Sample grand mean
Sul.- Sulfide separation technique
Hyd.- Hydroxide separation technique
S/H - Ratio between sulfide and hydroxide separation techniques

Table 4

ISO/TC 183/WG 4A - Copper in Copper Concentrates-Electrogravimetric Method
Statistical test for the ratio of precision obtained
by sulfide and hydroxide separation techniques

Sample	Within-Lab. Var.						Between-Lab. Mean Squares					
No.	Sul.	fs	Hyd.	fh	Fc	*	Sul.	fs	Hyd.	fh	Fc	*
85-6	0.00276	34	0.00084	29	3.29	R	0.02426	16	0.01681	14	1.44	I
85-7	0.00692	36	0.00082	30	8.42	R	0.05654	17	0.01173	14	4.82	R
85-8	0.00369	33	0.00288	34	1.28	I	0.03366	16	0.03693	16	0.91	I
85-9	0.00535	34	0.00228	38	2.35	R	0.12586	16	0.13589	18	0.92	I
85-10A	0.00363	28	0.00114	30	3.18	R	0.03499	13	0.01623	14	2.16	I

R - There is evidence that there is difference between the precision of the two techniques
I - There is no evidence that there is difference between the precision of the two techniques
fs - Degrees of freedom associated with Sul.
fh - Degrees of freedom associated with Hyd.
* At 5% significant level

Table 5

Copper in Copper Concentrates-Electrogravimetric Method
Statistical test for the difference between sample grand mean obtained by sulfide and hydroxide separation techniques

Sample No.	Xs % Cu	Xh % Cu	|Xs-Xh| % Cu	V[Xs] x 10**3	V[Xh] x 10**3	Sd	T*
85-6	19.851	19.890	0.039	0.4756	0.3848	0.0293	1.33
85-7	24.212	24.330	0.118	1.0471	0.2606	0.0362	3.26*
85-8	33.363	33.397	0.034	0.6773	0.7242	0.0374	0.91
85-9	50.406	50.530	0.124	2.4678	2.3841	0.0697	1.78
85-10A	28.681	28.716	0.035	0.8332	0.3607	0.0346	1.01

Xs - Sample grand mean by sulfide separation technique
Xh - Sample grand mean by hydroxide separation technique
V[Xs] - Variance of Xs
V[Xh] - Variance of Xh

Sd = {V[Xs] + V[Xh]}**0.5

T = |Xs - Xh|/Sd

* If T is greater than 2, the difference between the means obtained by the two methods is statistically significant (4)

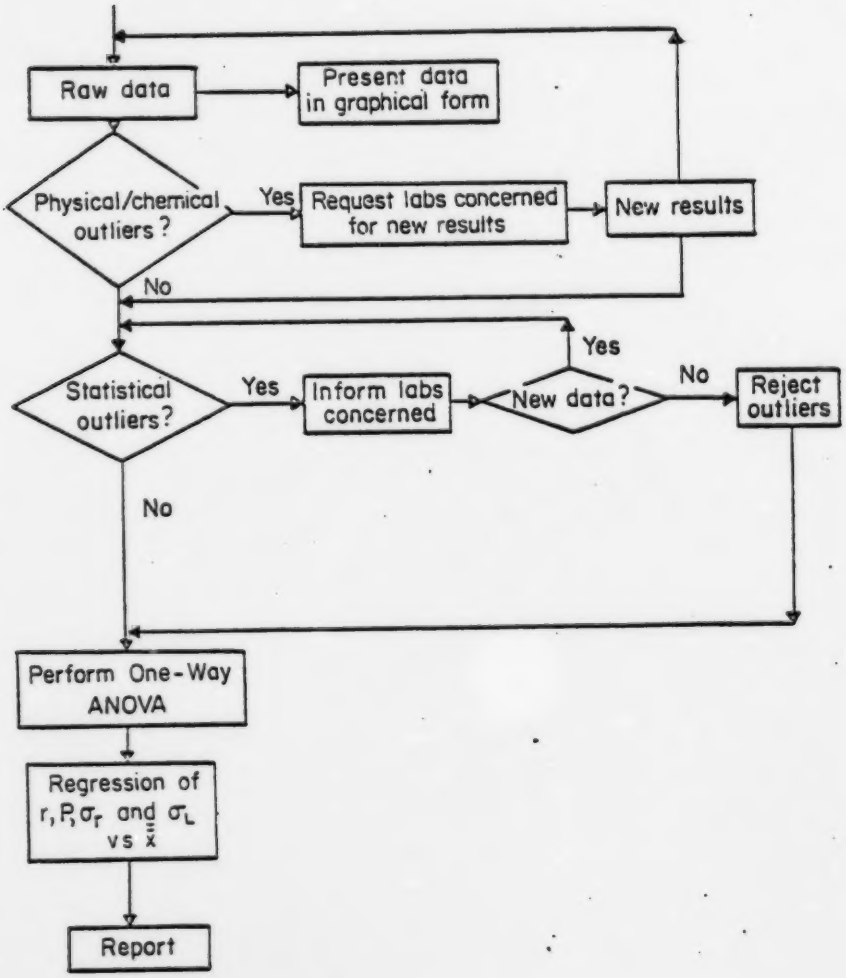

Figure 1. Flow Chart of the Procedure for Statistical Evaluation of Analytical Data Resulting from International Tests If The Test Sample is Known to be Homogeneous.

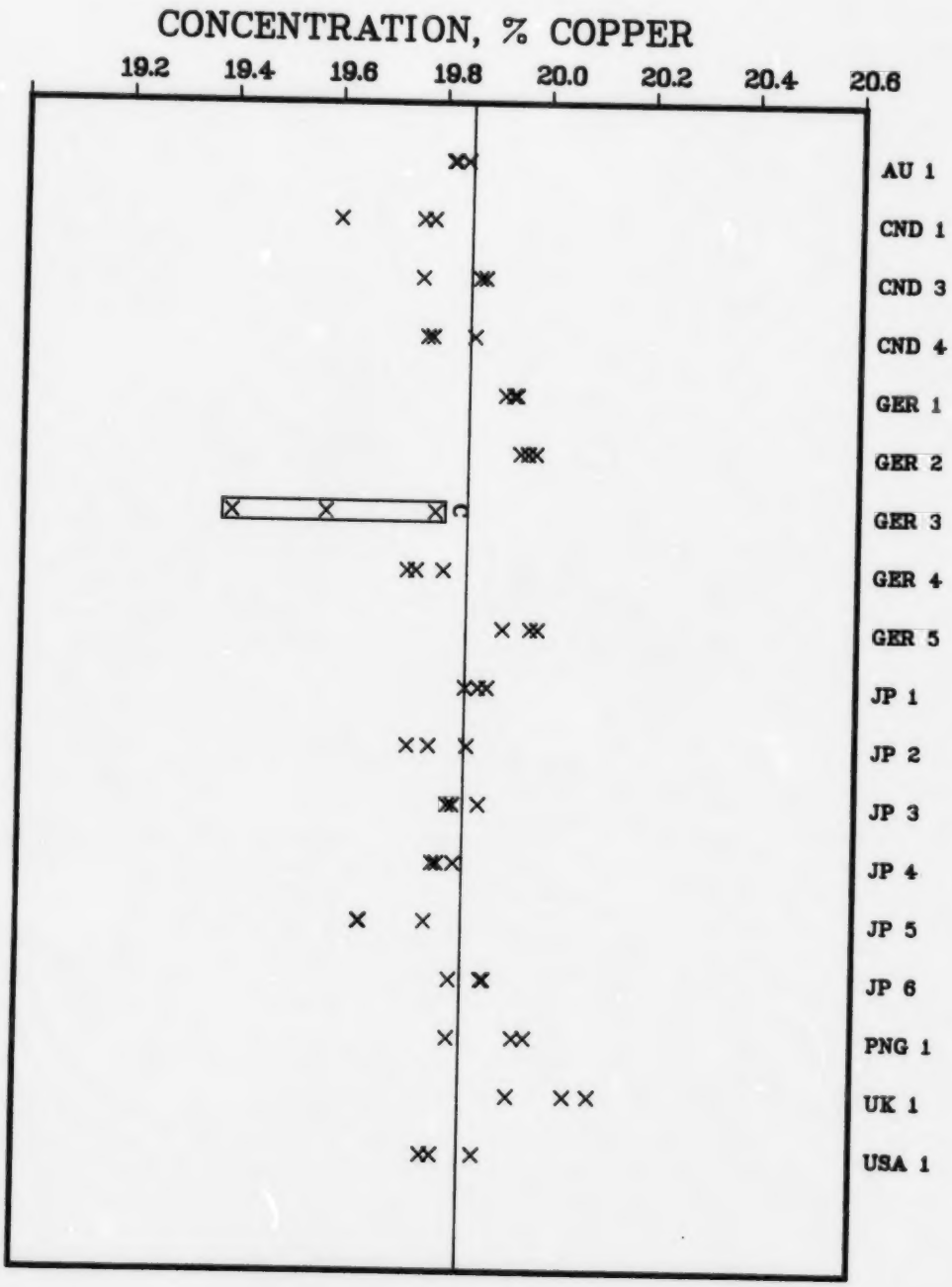

Figure 2.1. Sul ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/SULFIDE SAMPLE 85-6

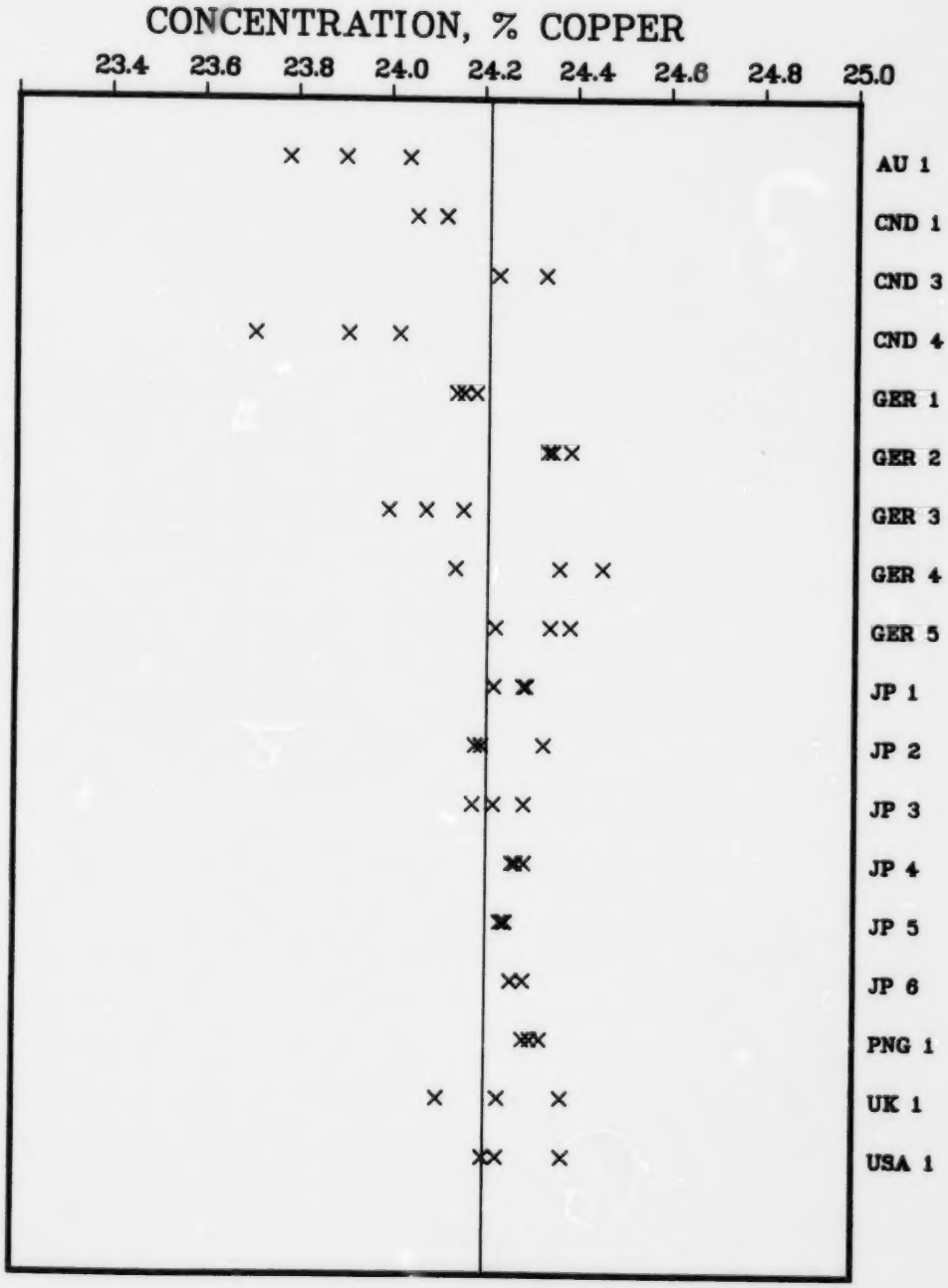

Figure 2.2.Sul ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/SULFIDE SAMPLE 85-7

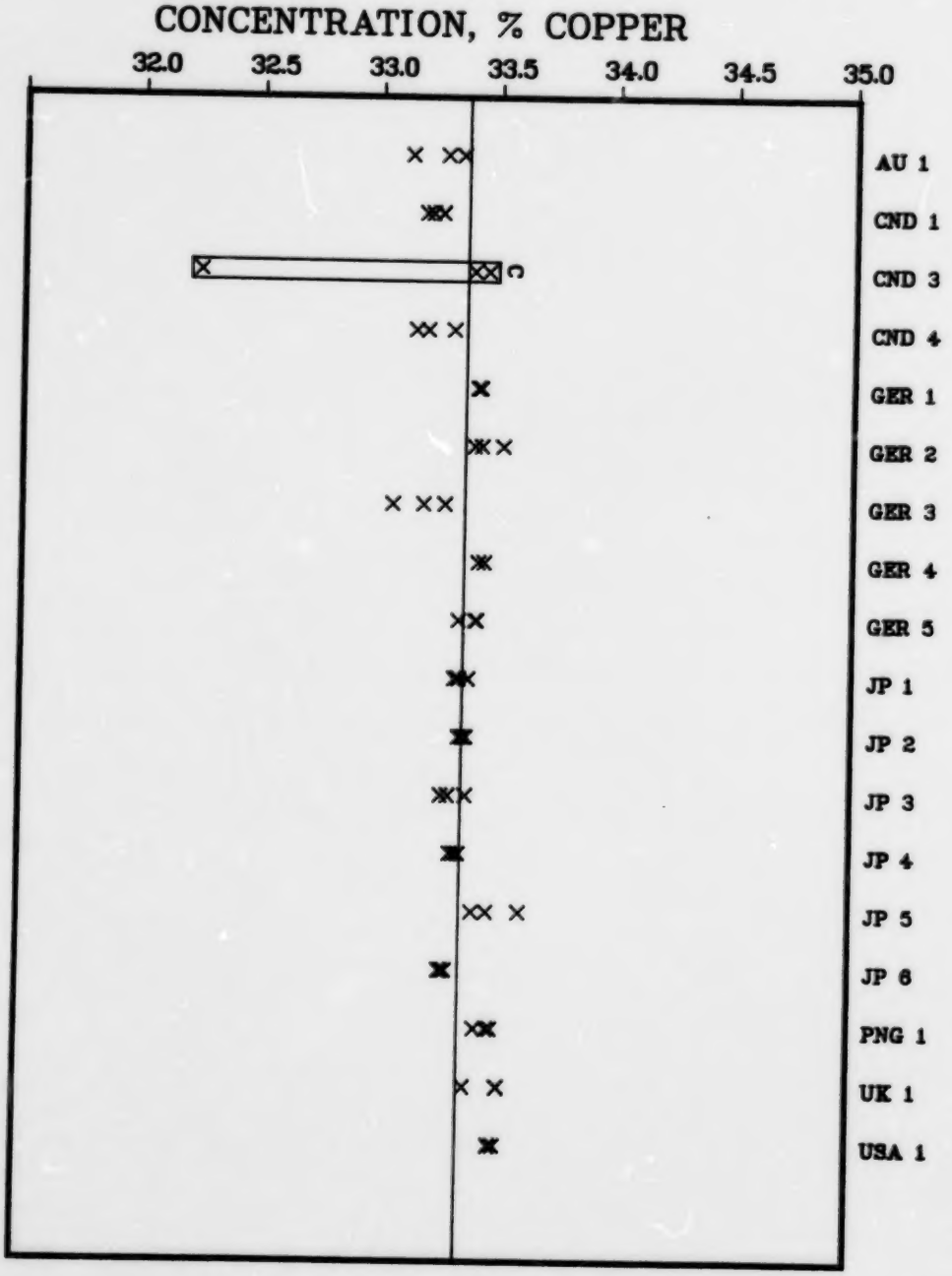

Figure 2.3.Sul ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE SAMPLE 85-8

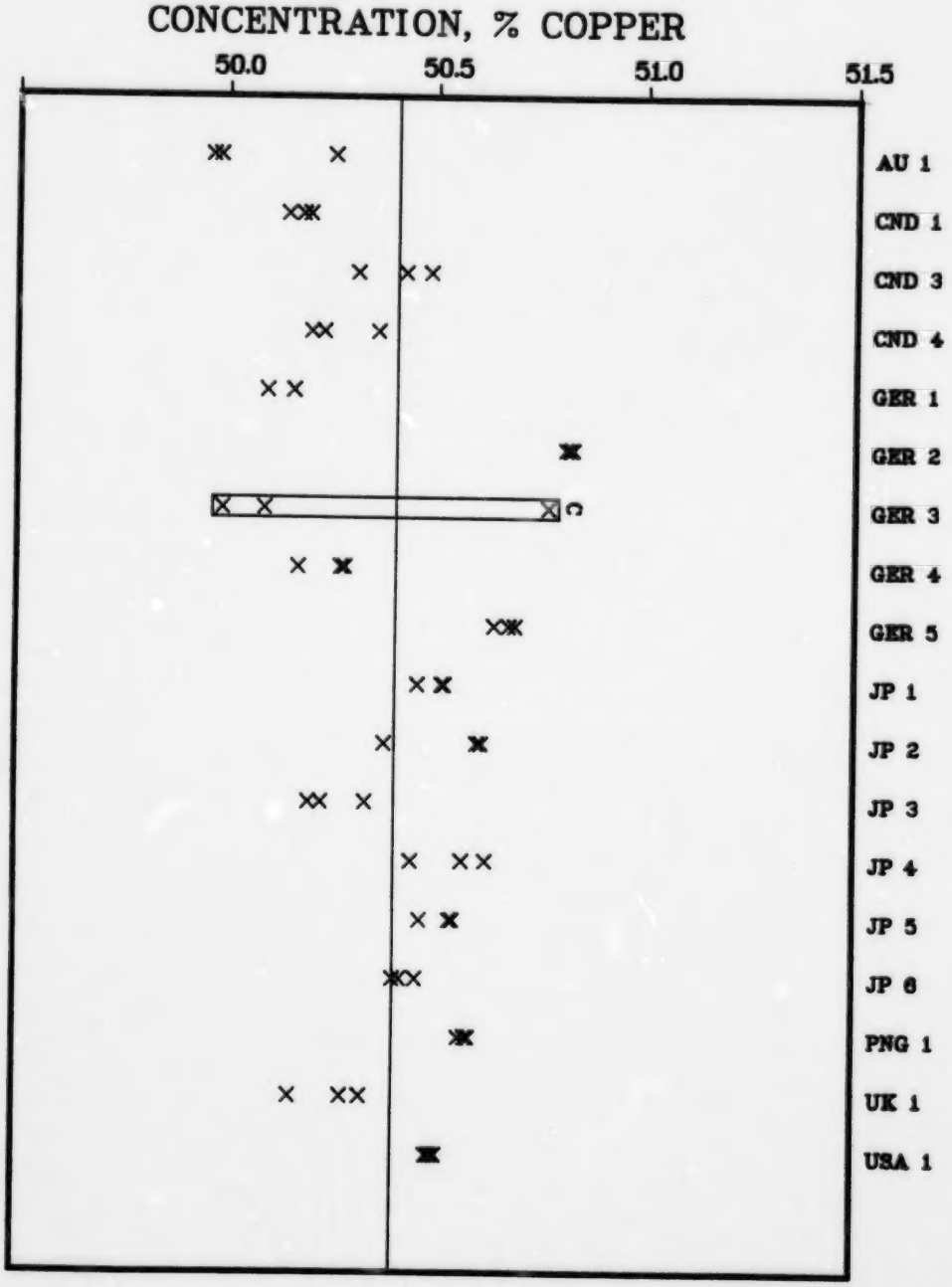

Figure 2.4.Sul ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/SULFIDE SAMPLE 85-9

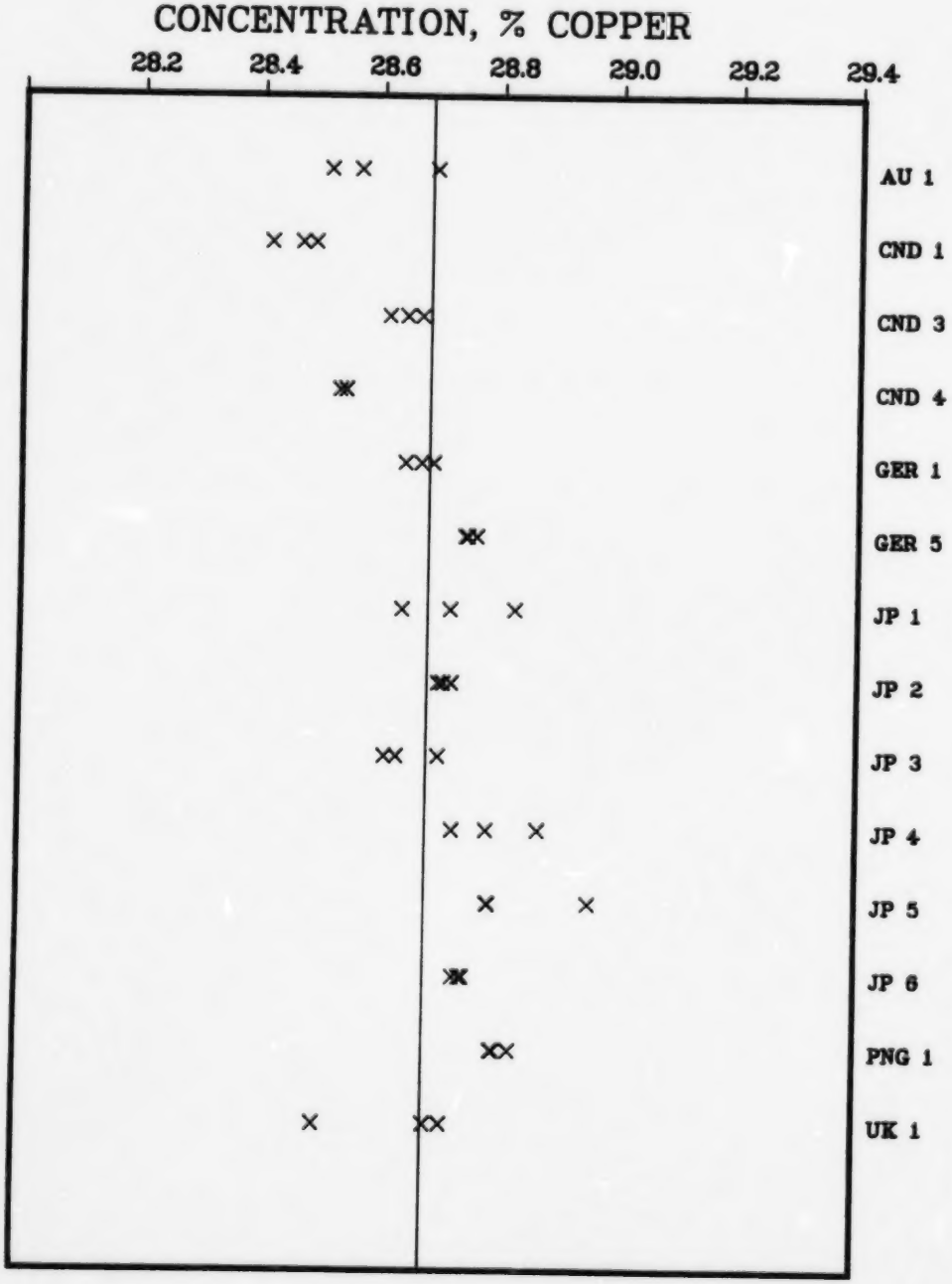

Figure 2.5.Sul ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/SULFIDE SAMPLE 85-10A

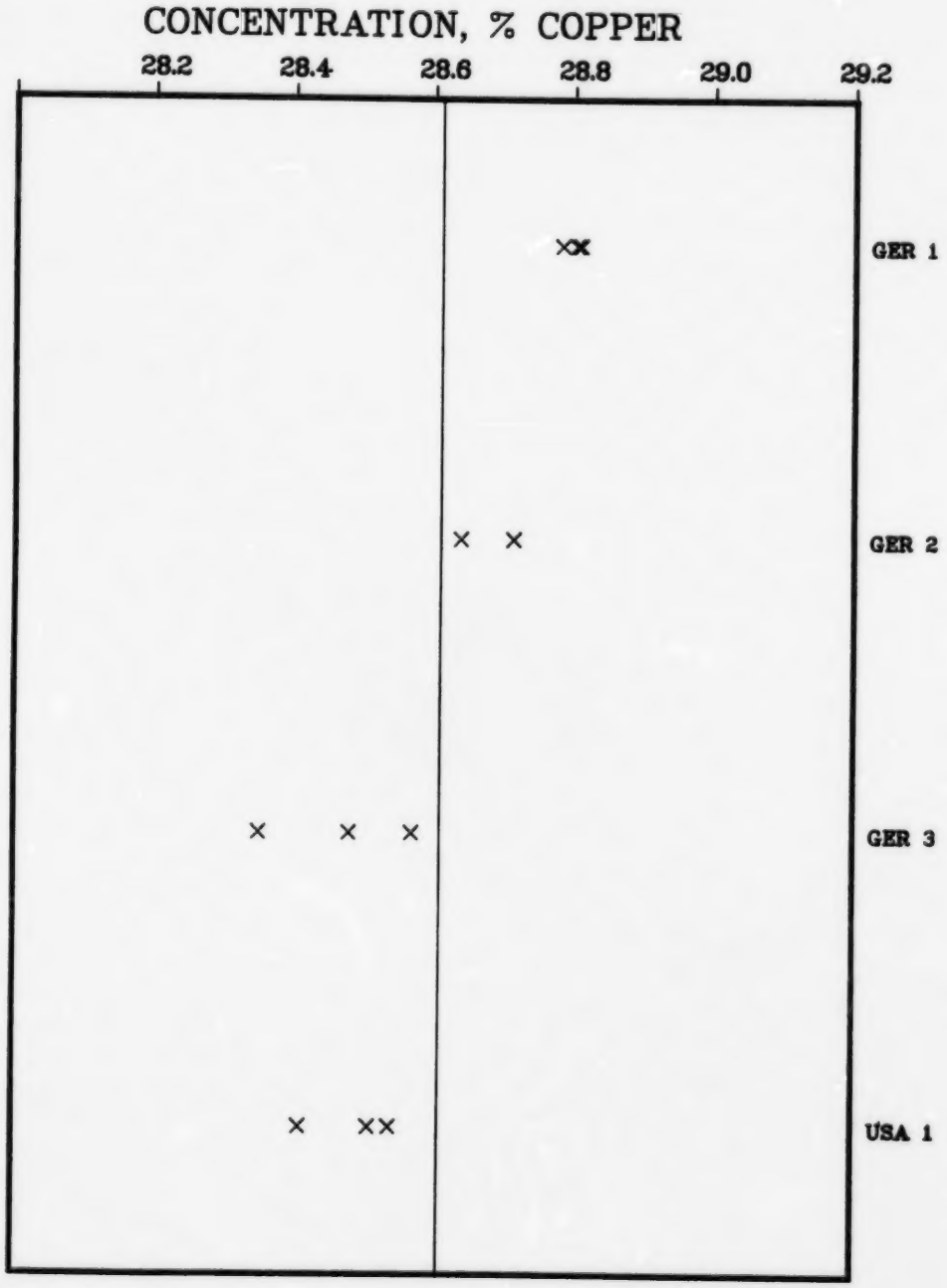

Figure 2.6.Sul ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE SAMPLE 85-10

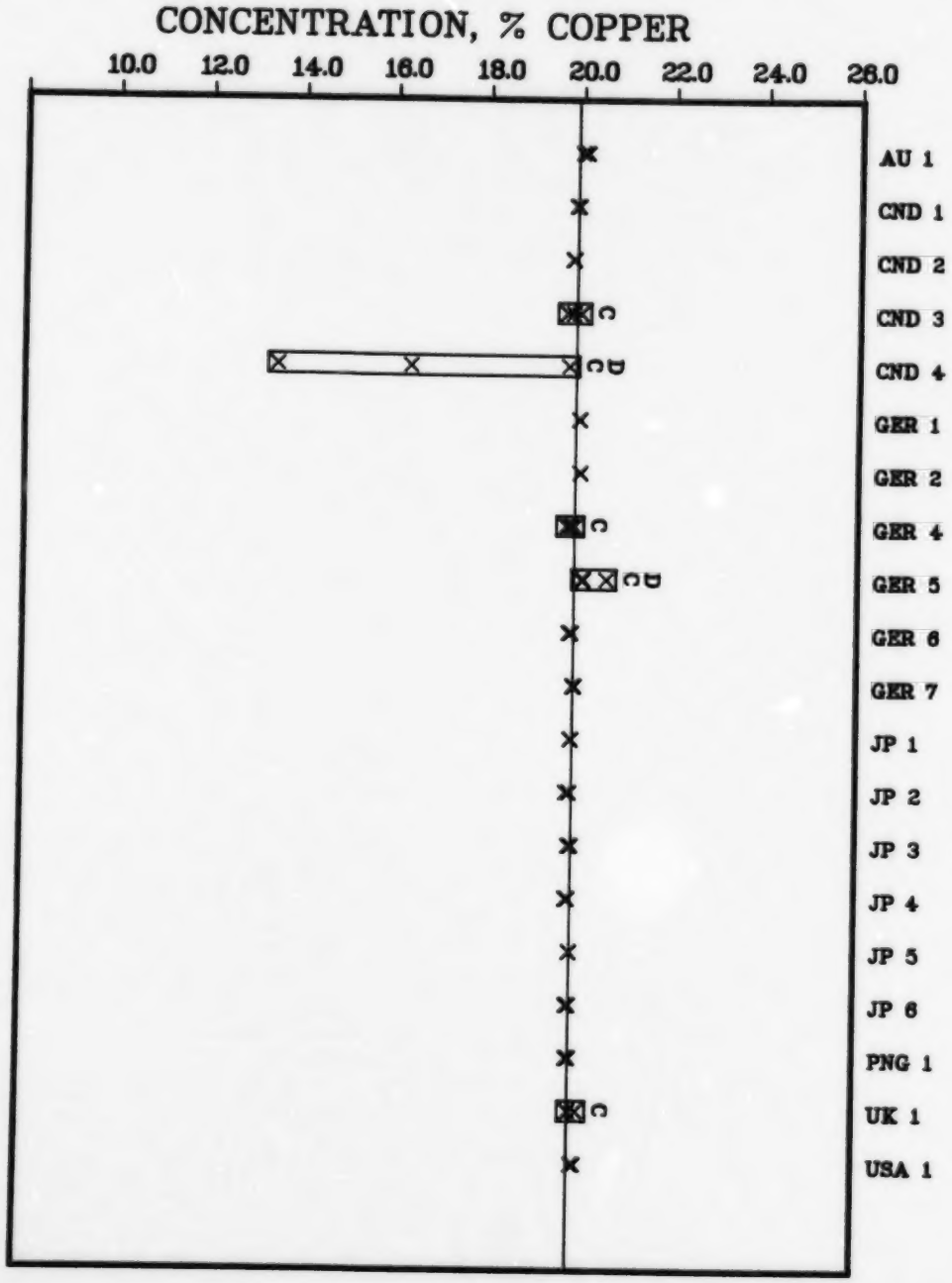

Figure 2.1.H ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE SAMPLE 95-6

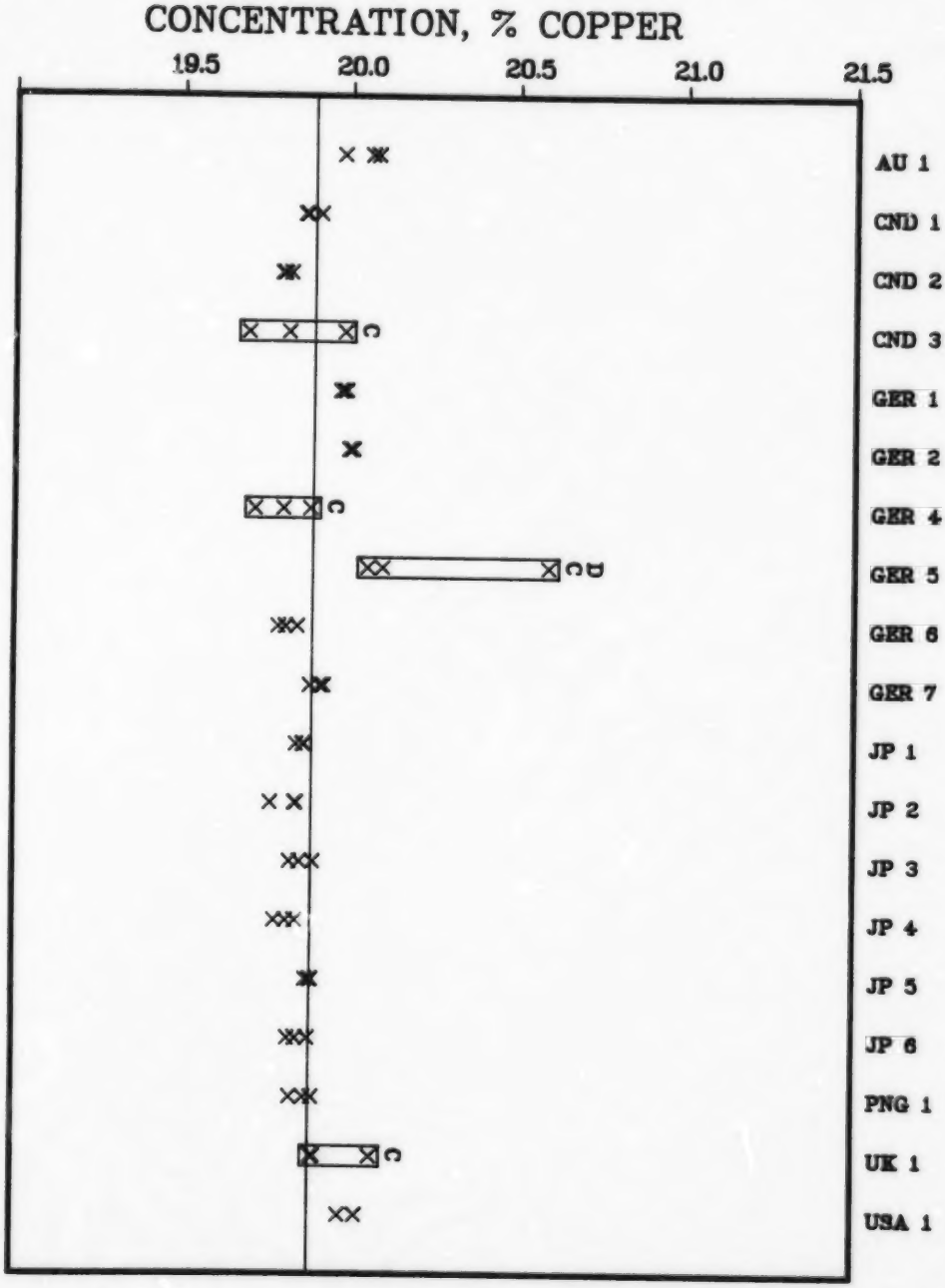

Figure 2.1.H

Figure 2.1.H.A ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE SAMPLE 85-8

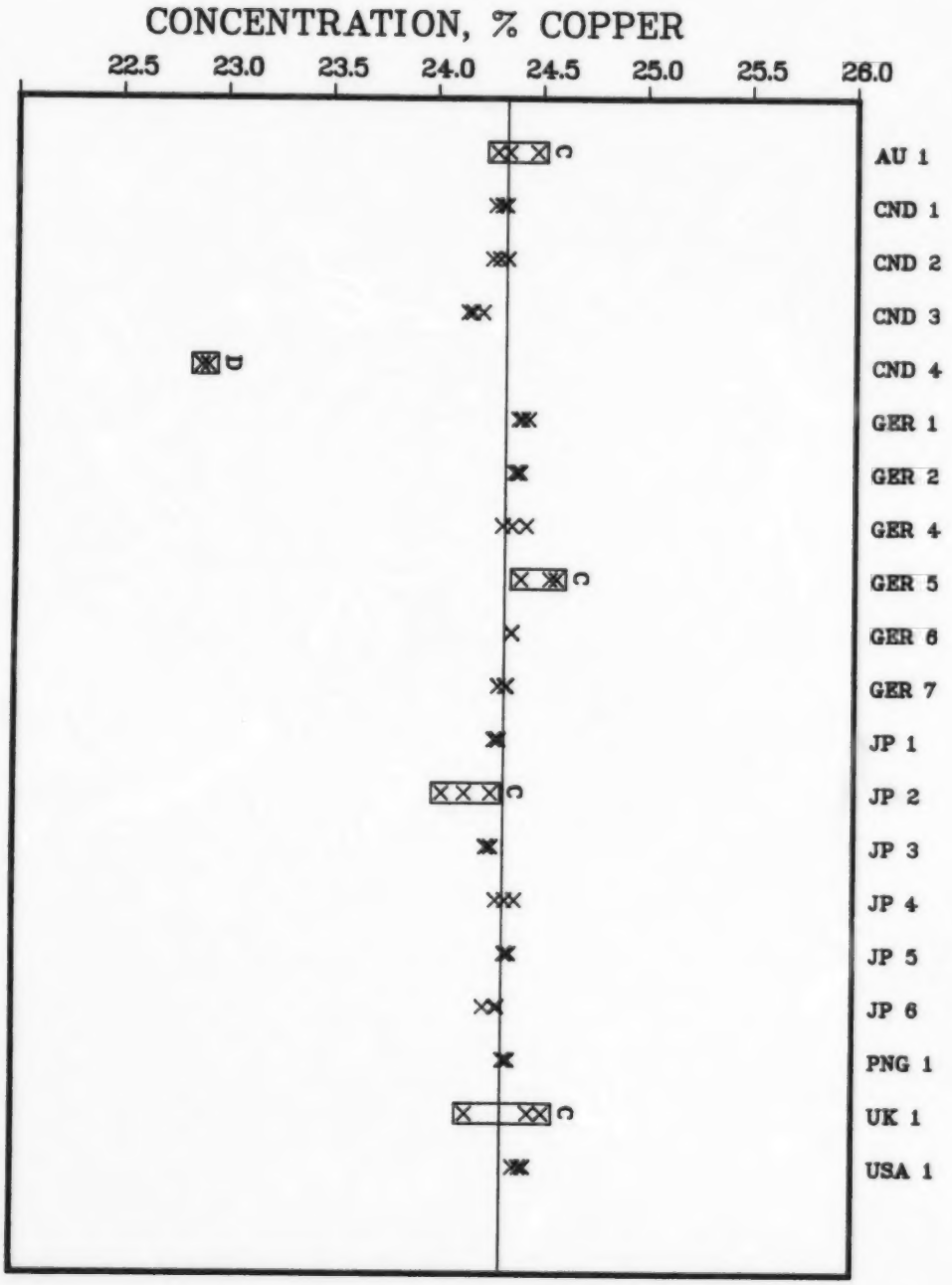

Figure 2.2.H ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE SAMPLE 85-7

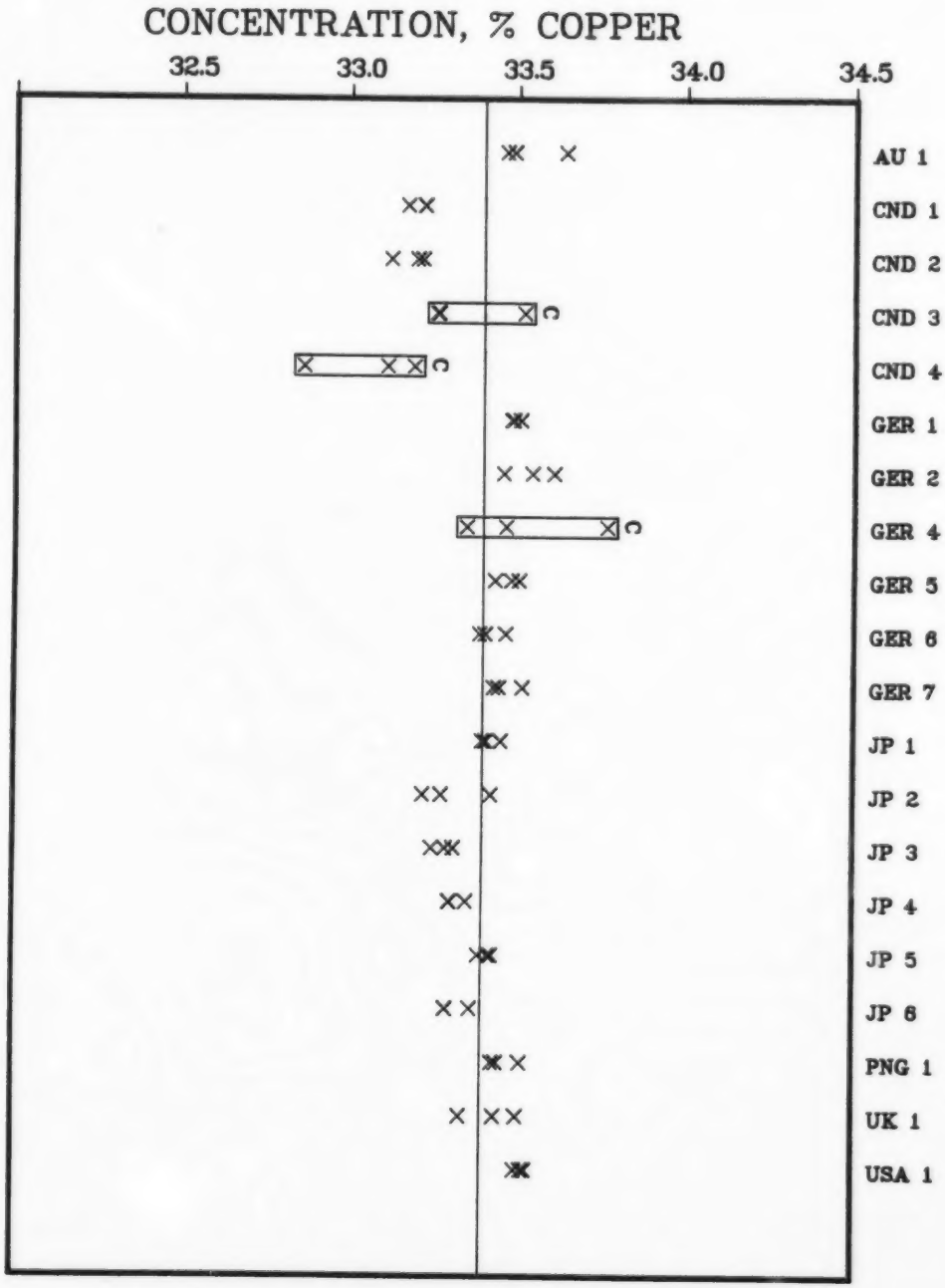

Figure 2.3.H ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE SAMPLE: 85-8

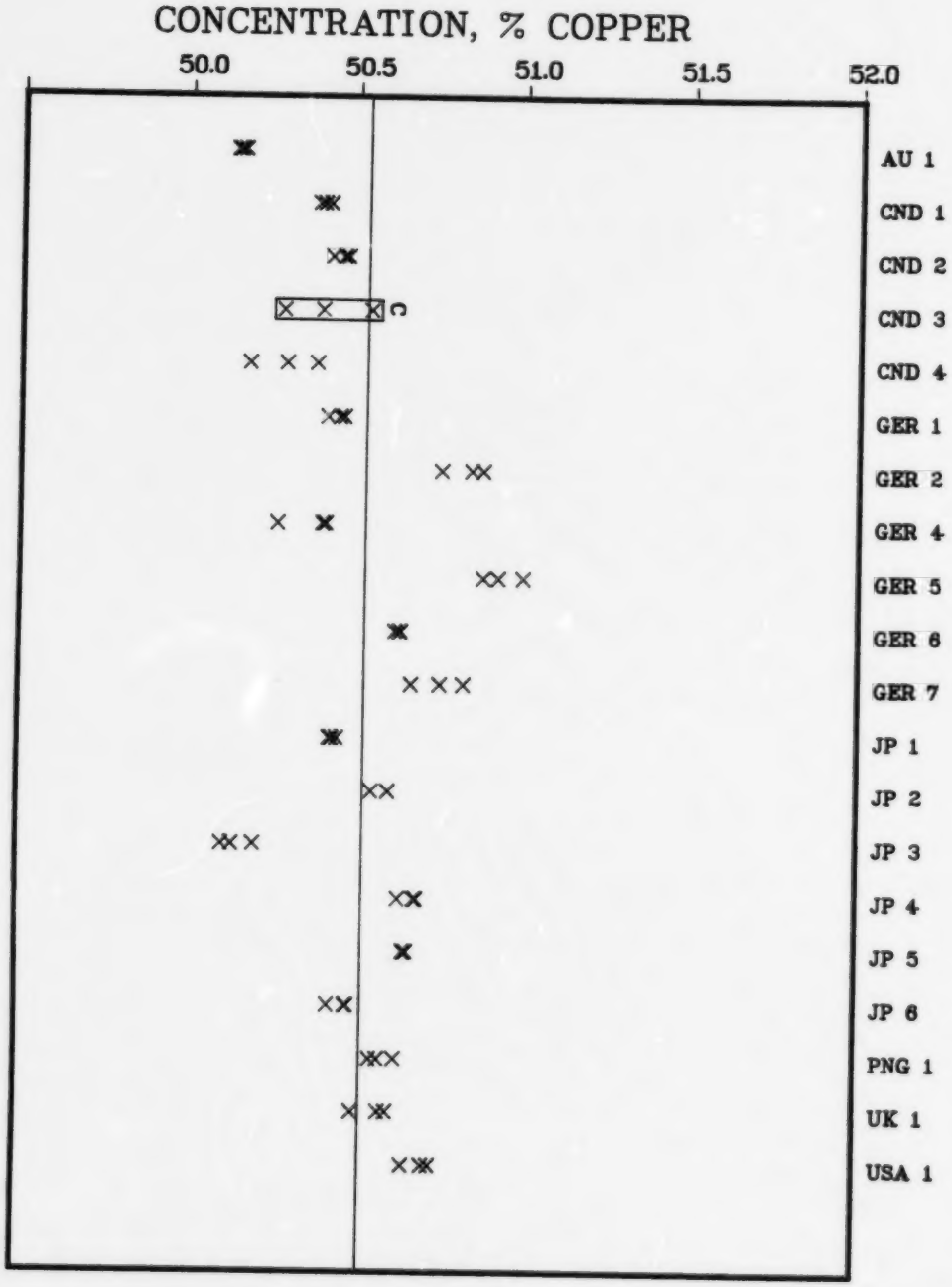

Figure 2.4.H ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE SAMPLE: 85-9

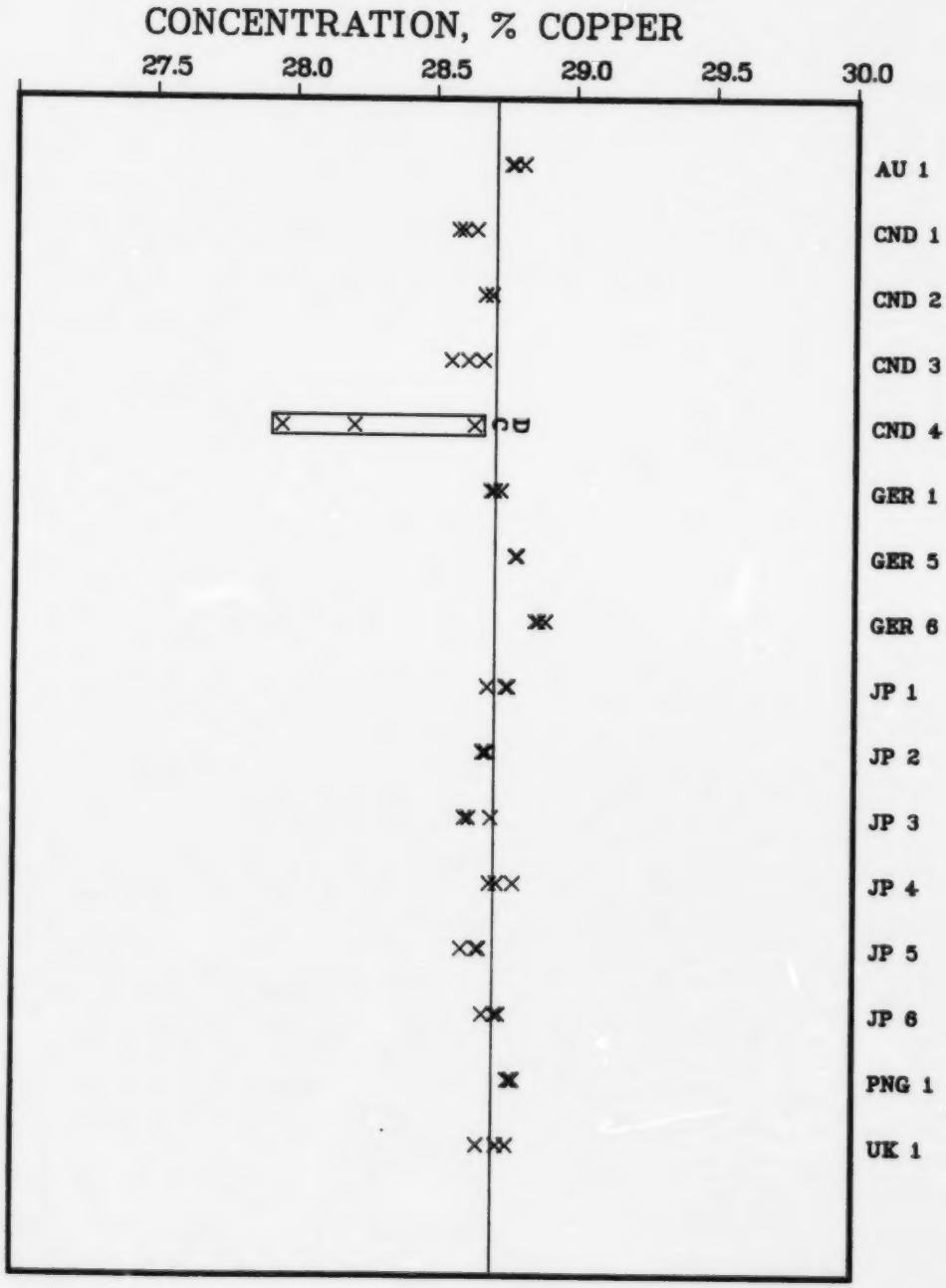

Figure 2.5.H ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE SAMPLE: 85-10A

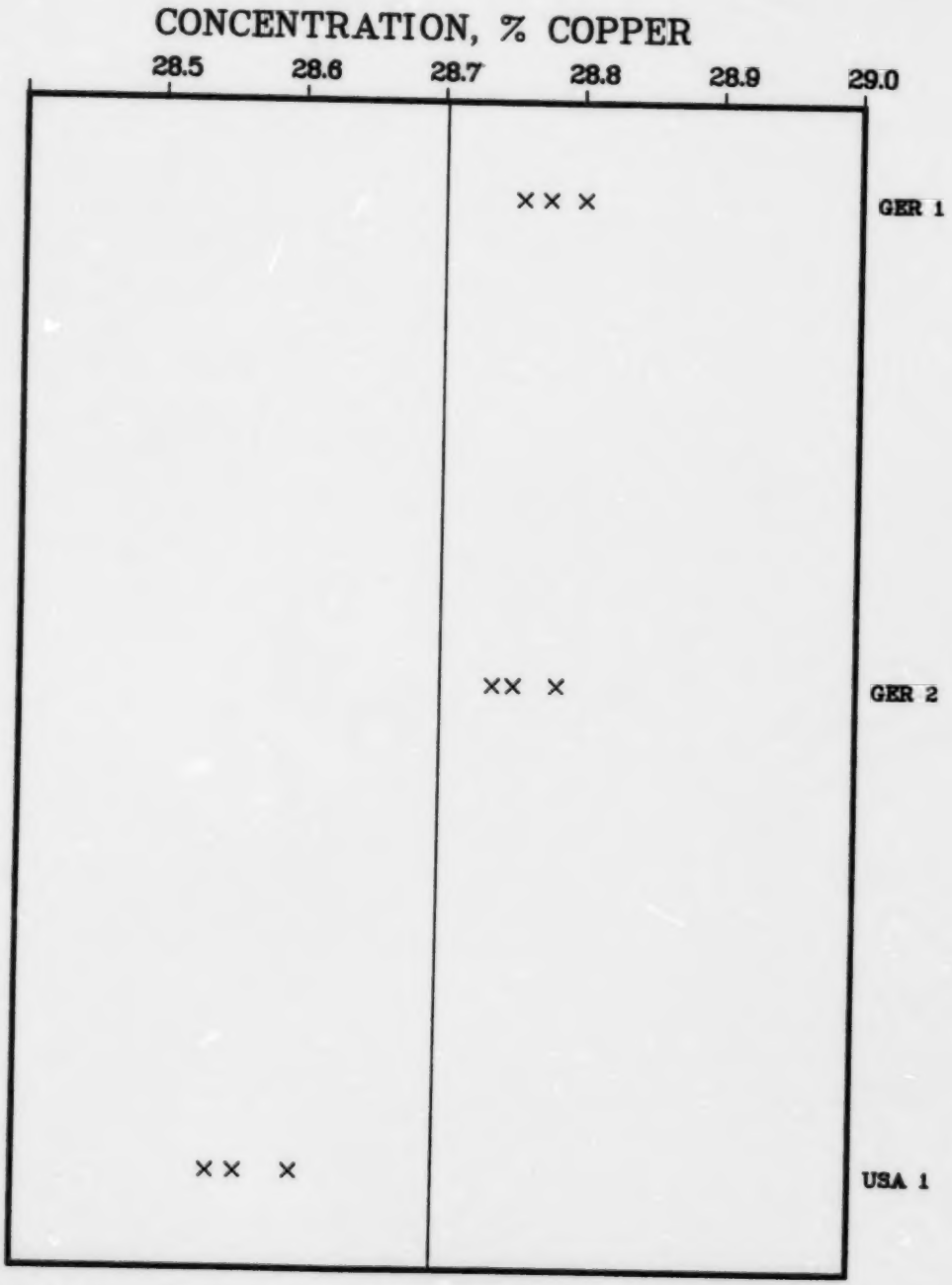

Figure 2.6.H ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE SAMPLE 85-10

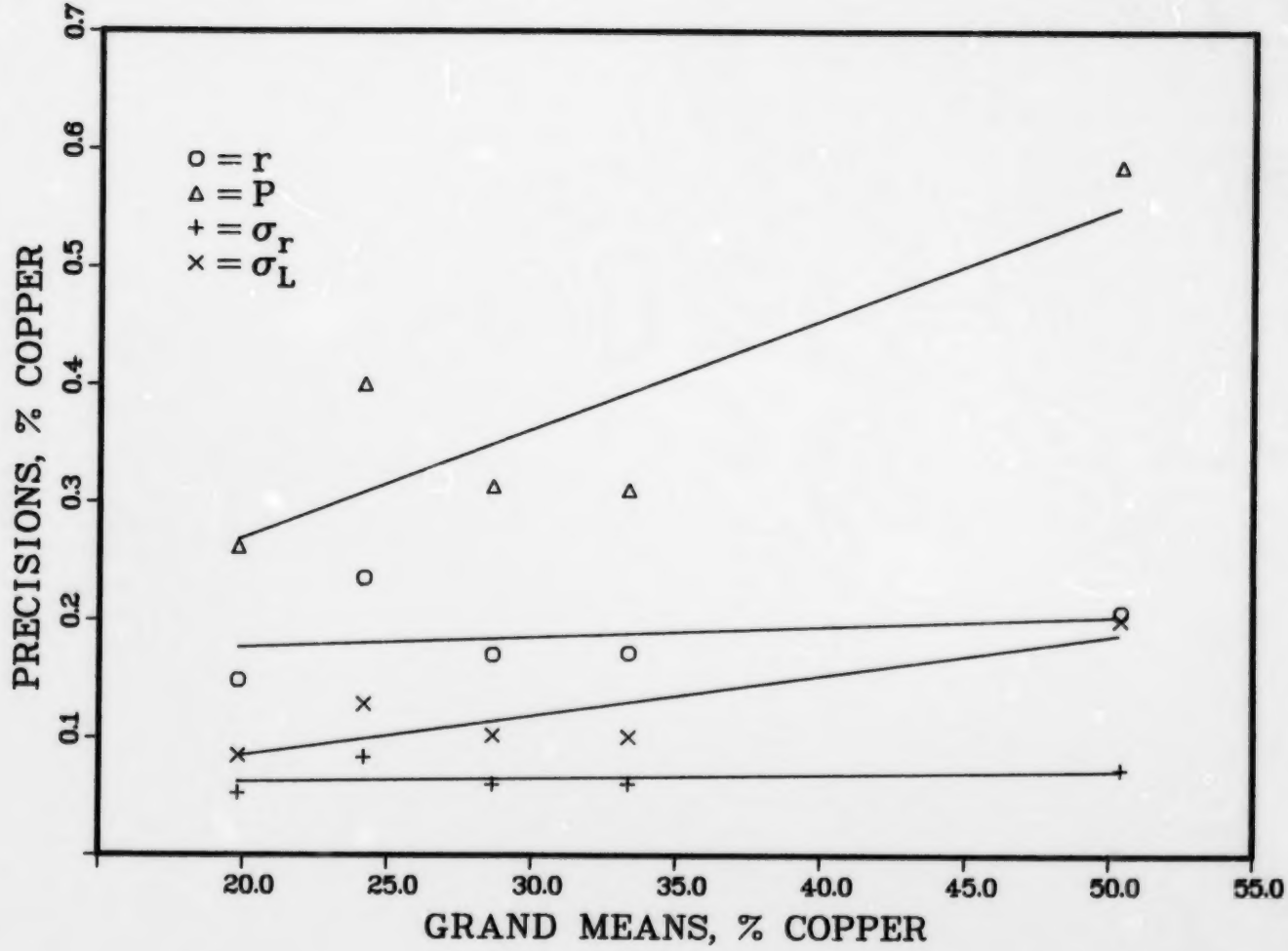

Figure 3.Sul ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE

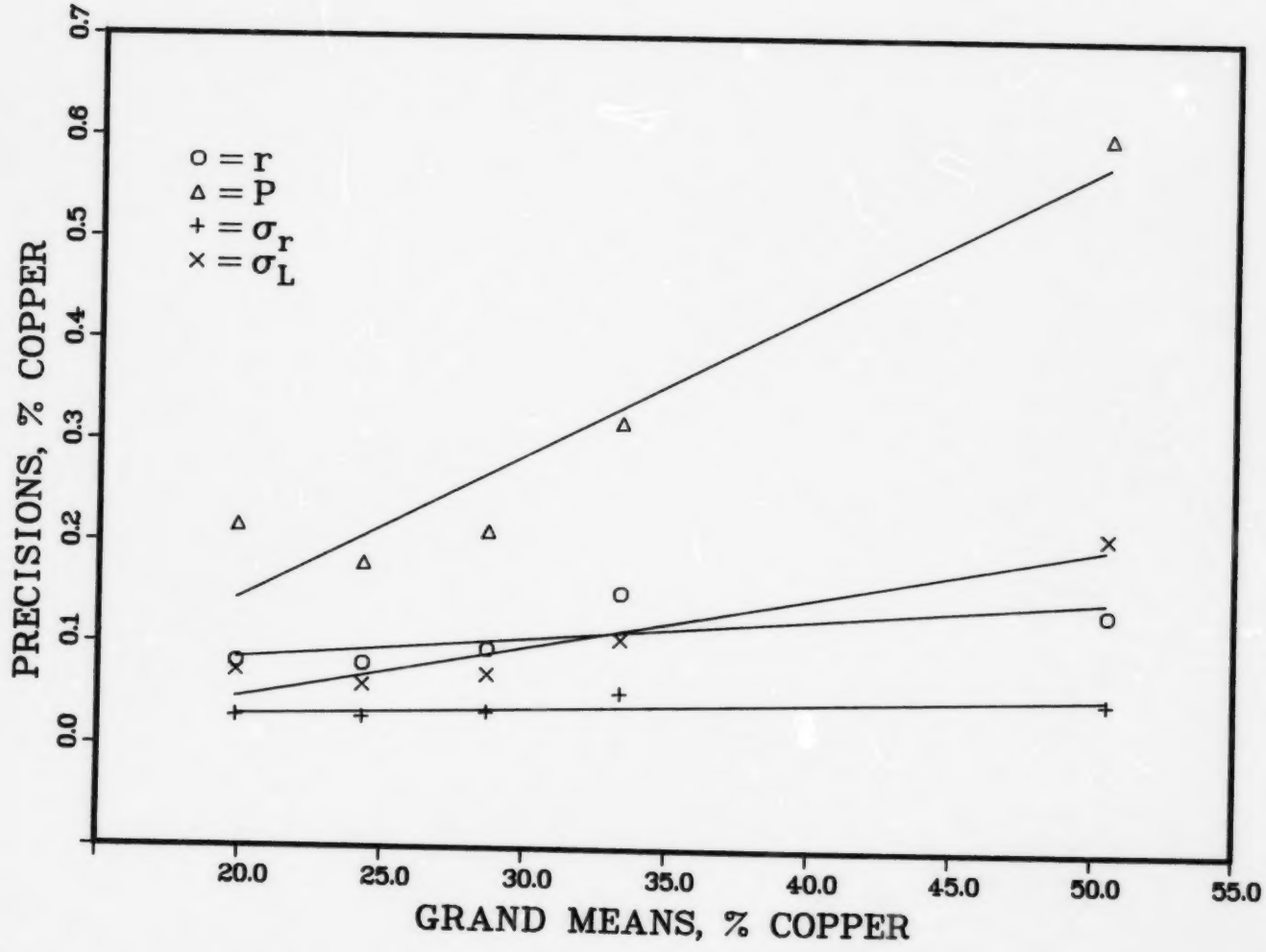

Figure 3.H

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. – ELECTROGRAVIMETRIC/HYDROXID

Appendix A.Sul

Detailed Computation of Analytical Data

Sulfide Separation Technique

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	19.8140	19.8420	19.8190	19.82500	.2230E-03
2	CND 1	1	19.7790	19.7590	19.6000	19.71267	.9620E-02
3	CND 3	1	19.8690	19.7590	19.8790	19.83567	.4433E-02
4	CND 4	1	19.7700	19.8600	19.7800	19.80333	.2433E-02
5	GER 1	1	19.9430	19.9370	19.9210	19.93367	.1293E-03
6	GER 2	1	19.9510	19.9660	19.9810	19.96600	.2250E-03
7	GER 3	1	19.7900	19.5800	19.4000	19.59000	.3810E-01
8	GER 4	1	19.8070	19.7380	19.7550	19.76667	.1292E-02
9	GER 5	1	19.9220	19.9890	19.9740	19.96167	.1236E-02
10	JP 1	1	19.8770	19.8520	19.8940	19.87433	.4463E-03
11	JP 2	1	19.7840	19.8570	19.7430	19.79467	.3334E-02
12	JP 3	1	19.8310	19.8210	19.8810	19.84433	.1033E-02
13	JP 4	1	19.8350	19.7940	19.8030	19.81067	.4643E-03
14	JP 5	1	19.7810	19.6540	19.6570	19.69733	.5252E-02
15	JP 6	1	19.8910	19.8960	19.8300	19.87233	.1350E-02
16	PNG 1	1	19.8280	19.9530	19.9750	19.91867	.6286E-02
17	UK 1	1	20.0520	19.9440	20.0990	20.03167	.6316E-02
18	USA 1	1	19.8000	19.8800	19.7800	19.82000	.2800E-02

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	30.426
CHI-SQUARE(.95,17)	27.593

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

GER 3 C-CALC = .448 C-CRIT(3,18) = .293

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

GER 3 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	16	.38812518E+00	.24257824E-01
WITHIN LABS	34	.93753334E-01	.27574510E-02
TOTAL	50	.48187851E+00	

REPEATABILITY VARIANCE	.27574510E-02
REPEATABILITY STD. DEV.	.05251144
BETWEEN-LABORATORIES VARIANCE	.71667908E-02
BETWEEN-LABORATORIES STD. DEV.	.08465690
REPEATABILITY	.14860737
PERMISSIBLE TOLERANCE BETWEEN LABS	.26161075
GRAND MEAN	19.85109804
VARIANCE OF THE GRAND MEAN	.47564360E-03

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-7

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	23.9020	23.7810	24.0390	23.90733	.1666E-01
2	CND 1	1	24.1200	24.0560	24.1190	24.09833	.1344E-02
3	CND 3	1	24.2330	24.3340	24.3340	24.30033	.3400E-02
4	CND 4	1	24.0200	23.9100	23.7100	23.88000	.2470E-01
5	GER 1	1	24.1440	24.1600	24.1860	24.16333	.4493E-03
6	GER 2	1	24.3900	24.3500	24.3400	24.36000	.7000E-03
7	GER 3	1	24.1600	24.0800	24.0000	24.08000	.6400E-02
8	GER 4	1	24.4590	24.3670	24.1440	24.32333	.2624E-01
9	GER 5	1	24.3480	24.2310	24.3910	24.32333	.6856E-02
10	JP 1	1	24.2970	24.2280	24.2910	24.27200	.1461E-02
11	JP 2	1	24.2010	24.1880	24.3350	24.24133	.6622E-02
12	JP 3	1	24.1830	24.2280	24.2930	24.23467	.3058E-02
13	JP 4	1	24.2940	24.2680	24.2760	24.27933	.1773E-03
14	JP 5	1	24.2430	24.2510	24.2550	24.24967	.3733E-04
15	JP 6	1	24.2680	24.2670	24.2940	24.27633	.2343E-03
16	PNG 1	1	24.2940	24.3310	24.3100	24.31167	.3443E-03
17	UK 1	1	24.1110	24.2420	24.3770	24.24333	.1769E-01
18	USA 1	1	24.2400	24.2100	24.3800	24.27667	.8233E-02

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-7

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	34.970
CHI-SQUARE(.95,17)	27.593

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

NONE REJECTED

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-7

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	17	.96124950E+00	.56544088E-01
WITHIN LABS	36	.24921533E+00	.69226482E-02
TOTAL	53	.12104648E+01	

REPEATABILITY VARIANCE	.69226482E-02
REPEATABILITY STD. DEV.	.08320245
BETWEEN-LABORATORIES VARIANCE	.16540480E-01
BETWEEN-LABORATORIES STD. DEV.	.12860980
REPEATABILITY	.23546294
PERMISSIBLE TOLERANCE BETWEEN LABS	.40024049
GRAND MEAN	24.21227778
VARIANCE OF THE GRAND MEAN	.10471127E-02

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-8

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	33.2740	33.3400	33.1250	33.24633	.1213E-01
2	CND 1	1	33.1880	33.2140	33.2560	33.21933	.1177E-02
3	CND 3	1	33.4530	33.3930	32.2410	33.02900	.4666E+00
4	CND 4	1	33.1500	33.2000	33.3100	33.22000	.6700E-02
5	GER 1	1	33.4170	33.4260	33.4130	33.41867	.4433E-04
6	GER 2	1	33.5230	33.4030	33.4330	33.45300	.3900E-02
7	GER 3	1	33.1900	33.0600	33.2800	33.17667	.1223E-01
8	GER 4	1	33.4230	33.4480		33.43550	.3125E-03
9	GER 5	1	33.4200	33.4130	33.3430	33.39200	.1813E-02
10	JP 1	1	33.3870	33.3290	33.3470	33.35433	.8813E-03
11	JP 2	1	33.3670	33.3500	33.3800	33.36567	.2263E-03
12	JP 3	1	33.3080	33.2780	33.3830	33.32300	.2925E-02
13	JP 4	1	33.3360	33.3550	33.3200	33.33700	.3070E-03
14	JP 5	1	33.4770	33.4160	33.6130	33.50200	.1017E-01
15	JP 6	1	33.3060	33.2910	33.2810	33.29267	.1583E-03
16	PNG 1	1	33.4340	33.4850	33.5020	33.47367	.1252E-02
17	UK 1	1	33.5320	33.5340	33.3910	33.48567	.6722E-02
18	USA 1	1	33.5200	33.5000	33.5000	33.50667	.1333E-03

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-8

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	83.096
CHI-SQUARE(.95,17)	27.593

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

CND 3 C-CALC = .884 C-CRIT(3,18) = .293

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

CND 3 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-8

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	16	.53856501E+00	.33660313E-01
WITHIN LABS	33	.12186317E+00	.36928232E-02
TOTAL	49	.66042818E+00	

REPEATABILITY VARIANCE	.36928232E-02
REPEATABILITY STD. DEV.	.06076860
BETWEEN-LABORATORIES VARIANCE	.10193024E-01
BETWEEN-LABORATORIES STD. DEV.	.10096051
REPEATABILITY	.17197515
PERMISSIBLE TOLERANCE BETWEEN LABS	.31051994
GRAND MEAN	33.36342000
VARIANCE OF THE GRAND MEAN	.67728348E-03

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-9

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	50.2540	49.9800	49.9620	50.06533	.2678E-01
2	CND 1	1	50.1430	50.1780	50.1950	50.17200	.7030E-03
3	CND 3	1	50.3100	50.4250	50.4850	50.40667	.7908E-02
4	CND 4	1	50.3600	50.2300	50.2000	50.26333	.7233E-02
5	GER 1	1	50.1590	50.1590	50.0960	50.13800	.1323E-02
6	GER 2	1	50.8260	50.8210	50.8110	50.81933	.5833E-04
7	GER 3	1	50.7700	49.9900	50.0900	50.28333	.1801E+00
8	GER 4	1	50.2830	50.1720	50.2740	50.24300	.3801E-02
9	GER 5	1	50.6770	50.6920	50.6420	50.67033	.6583E-03
10	JP 1	1	50.5180	50.4600	50.5240	50.50067	.1249E-02
11	JP 2	1	50.3810	50.6030	50.6130	50.53233	.1720E-01
12	JP 3	1	50.2300	50.2000	50.3360	50.25533	.5105E-02
13	JP 4	1	50.4470	50.5690	50.6250	50.54700	.8284E-02
14	JP 5	1	50.5400	50.5480	50.4690	50.51900	.1891E-02
15	JP 6	1	50.4060	50.4220	50.4600	50.42933	.7693E-03
16	PNG 1	1	50.5640	50.5870	50.5790	50.57667	.1363E-03
17	UK 1	1	50.1590	50.2830	50.3290	50.25700	.7732E-02
18	USA 1	1	50.4900	50.5100	50.5000	50.50000	.1000E-03

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-9

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	56.717
CHI-SQUARE(.95,17)	27.593

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

GER 3 C-CALC = .665 C-CRIT(3,18) = .293

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

GER 3 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-9

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	16	.20137555E+01	.12585972E+00
WITHIN LABS	34	.18186267E+00	.53489020E-02
TOTAL	50	.21956182E+01	

REPEATABILITY VARIANCE	.53489020E-02
REPEATABILITY STD. DEV.	.07313619
BETWEEN-LABORATORIES VARIANCE	.40170272E-01
BETWEEN-LABORATORIES STD. DEV.	.20042523
REPEATABILITY	.20697541
PERMISSIBLE TOLERANCE BETWEEN LABS	.58578076
GRAND MEAN	50.40560784
VARIANCE OF THE GRAND MEAN	.24678376E-02

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-10A

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	28.6890	28.5120	28.5620	28.58767	.8326E-02
2	CND 1	1	28.4650	28.4870	28.4140	28.45533	.1402E-02
3	CND 3	1	28.6420	28.6120	28.6670	28.64033	.7583E-03
4	CND 4	1	28.5400	28.5400	28.5300	28.53667	.3333E-04
5	GER 1	1	28.6880	28.6410	28.6680	28.66567	.5563E-03
6	GER 5	1	28.7430	28.7470	28.7620	28.75067	.1003E-03
7	JP 1	1	28.6380	28.7190	28.8270	28.72800	.8991E-02
8	JP 2	1	28.7000	28.7080	28.7220	28.71000	.1240E-03
9	JP 3	1	28.6310	28.7010	28.6110	28.64767	.2233E-02
10	JP 4	1	28.8690	28.7830	28.7260	28.79267	.5182E-02
11	JP 5	1	28.7860	28.7880	28.9550	28.84300	.9409E-02
12	JP 6	1	28.7410	28.7300	28.7460	28.73900	.6700E-04
13	PNG 1	1	28.7960	28.8250	28.7990	28.80667	.2543E-03
14	UK 1	1	28.7120	28.4990	28.6850	28.63200	.1345E-01

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-10A

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	31.984
CHI-SQUARE(.95,13)	22.367

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

NONE REJECTED

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-10A

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	13	.45492762E+00	.34994432E-01
WITHIN LABS	28	.10177400E+00	.36347857E-02
TOTAL	41	.55670162E+00	

REPEATABILITY VARIANCE	.36347857E-02
REPEATABILITY STD. DEV.	.06028918
BETWEEN-LABORATORIES VARIANCE	.10453216E-01
BETWEEN-LABORATORIES STD. DEV.	.10224097
REPEATABILITY	.17061839
PERMISSIBLE TOLERANCE BETWEEN LABS	.31348696
GRAND MEAN	28.68109524
VARIANCE OF THE GRAND MEAN	.83320077E-03

Appendix A.H

Detailed Computation of Analytical Data

Hydroxide Separation Technique

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-6

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	20.0590	20.0760	19.9760	20.03700	.2863E-02
2	CND 1	1	19.8600	19.8670	19.9070	19.87800	.6430E-03
3	CND 2	1	19.8190	19.8000	19.7930	19.80400	.1810E-03
4	CND 3	1	19.9800	19.8140	19.6940	19.82933	.2063E-01
5	CND 4	1	19.7400	13.4400	16.3300	16.50333	.9945E+01
6	GER 1	1	19.9760	19.9690	19.9850	19.97667	.6433E-04
7	GER 2	1	20.0010	19.9960	20.0060	20.00100	.2500E-04
8	GER 4	1	19.8820	19.8010	19.7160	19.79967	.6890E-02
9	GER 5	1	20.5910	20.0970	20.0530	20.24700	.8924E-01
10	GER 6	1	19.7880	19.8110	19.8460	19.81500	.8530E-03
11	GER 7	1	19.9240	19.9140	19.8840	19.90733	.4333E-03
12	JP 1	1	19.8440	19.8650	19.8670	19.85867	.1623E-03
13	JP 2	1	19.8450	19.7670	19.8410	19.81767	.1929E-02
14	JP 3	1	19.8260	19.8960	19.8560	19.85933	.1233E-02
15	JP 4	1	19.8160	19.8450	19.7820	19.81433	.9943E-03
16	JP 5	1	19.8950	19.8900	19.8770	19.88733	.8633E-04
17	JP 6	1	19.8250	19.8490	19.8850	19.85300	.9120E-03
18	PNG 1	1	19.8990	19.8740	19.8330	19.86867	.1110E-02
19	UK 1	1	19.9050	20.0720	19.8980	19.95833	.9702E-02
20	USA 1	1	20.0300	19.9800		20.00500	.1250E-02

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-6

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	190.452
CHI-SQUARE(.95,19)	30.148

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

CND 4	C-CALC =	.986	C-CRIT(3,20) =	.270
GER 5	C-CALC =	.641	C-CRIT(3,19) =	.281
CND 3	C-CALC =	.413	C-CRIT(3,18) =	.293
UK 1	C-CALC =	.331	C-CRIT(3,17) =	.305
GER 4	C-CALC =	.351	C-CRIT(3,16) =	.319

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

CND 4	R =	.943	D-CRIT(20) =	.488
GER 5	R =	.559	D-CRIT(19) =	.501

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

CND 3	COCHRAN'S TEST FOR LABORATORY VARIANCE
CND 4	DIXON'S TEST FOR MEANS AND COCHRAN'S TEST FOR VARIANCE
GER 4	COCHRAN'S TEST FOR LABORATORY VARIANCE
GER 5	DIXON'S TEST FOR MEANS AND COCHRAN'S TEST FOR VARIANCE
UK 1	COCHRAN'S TEST FOR LABORATORY VARIANCE

A.3.H

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-6

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	14	.23529685E+00	.16806918E-01
WITHIN LABS	29	.24231333E-01	.83556322E-03
TOTAL	43	.25952818E+00	

REPEATABILITY VARIANCE	.83556322E-03
REPEATABILITY STD. DEV.	.02890611
BETWEEN-LABORATORIES VARIANCE	.54475938E-02
BETWEEN-LABORATORIES STD. DEV.	.07380782
REPEATABILITY	.08180429
PERMISSIBLE TOLERANCE BETWEEN LABS	.21673764
GRAND MEAN	19.88963636
VARIANCE OF THE GRAND MEAN	.38478924E-03

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-7

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	24.4730	24.3390	24.2830	24.36500	.9532E-02
2	CND 1	1	24.3280	24.2760	24.3070	24.30367	.6843E-03
3	CND 2	1	24.3350	24.2970	24.2630	24.29833	.1297E-02
4	CND 3	1	24.2190	24.1690	24.1490	24.17900	.1300E-02
5	CND 4	1	22.8800	22.8800	22.9100	22.89000	.3000E-03
6	GER 1	1	24.3930	24.4390	24.4100	24.41400	.5410E-03
7	GER 2	1	24.3750	24.4000	24.3900	24.38833	.1583E-03
8	GER 4	1	24.3640	24.4320	24.3190	24.37167	.3236E-02
9	GER 5	1	24.4070	24.5460	24.5760	24.50967	.8130E-02
10	GER 6	1	24.3640	24.3640	24.3650	24.36433	.3333E-06
11	GER 7	1	24.3020	24.3370	24.3420	24.32700	.4750E-03
12	JP 1	1	24.3020	24.3040	24.2840	24.29667	.1213E-03
13	JP 2	1	24.0360	24.2690	24.1440	24.14967	.1360E-01
14	JP 3	1	24.2480	24.2730	24.2530	24.25800	.1750E-03
15	JP 4	1	24.2980	24.3420	24.3870	24.34233	.1980E-02
16	JP 5	1	24.3470	24.3410	24.3640	24.35067	.1420E-03
17	JP 6	1	24.2420	24.3010	24.3100	24.28433	.1364E-02
18	PNG 1	1	24.3620	24.3370	24.3490	24.34933	.1563E-03
19	UK 1	1	24.4590	24.5260	24.1610	24.38200	.3775E-01
20	USA 1	1	24.4200	24.3900	24.4400	24.41667	.6333E-03

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-7

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	60.834
CHI-SQUARE(.95,19)	30.148

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

UK 1	C-CALC =	.463	C-CRIT(3,20) =	.270
JP 2	C-CALC =	.310	C-CRIT(3,19) =	.281
AU 1	C-CALC =	.315	C-CRIT(3,18) =	.293
GER 5	C-CALC =	.393	C-CRIT(3,17) =	.305

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

CND 4	R =	.846	D-CRIT(20) =	.488

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

AU 1	COCHRAN'S TEST FOR LABORATORY VARIANCE
CND 4	DIXON'S TEST FOR LABORATORY MEANS
GER 5	COCHRAN'S TEST FOR LABORATORY VARIANCE
JP 2	COCHRAN'S TEST FOR LABORATORY VARIANCE
UK 1	COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-7

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	14	.16416724E+00	.11726232E-01
WITHIN LABS	30	.24531333E-01	.81771112E-03
TOTAL	44	.18869858E+00	

REPEATABILITY VARIANCE	.81771112E-03
REPEATABILITY STD. DEV.	.02859565
BETWEEN-LABORATORIES VARIANCE	.36361735E-02
BETWEEN-LABORATORIES STD. DEV.	.06030069
REPEATABILITY	.08092569
PERMISSIBLE TOLERANCE BETWEEN LABS	.17998954
GRAND MEAN	24.32962222
VARIANCE OF THE GRAND MEAN	.26058293E-03

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-8

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	33.4860	33.4640	33.6400	33.53000	.9196E-02
2	CND 1	1	33.2210	33.2190	33.1690	33.20300	.8680E-03
3	CND 2	1	33.1200	33.2140	33.1980	33.17733	.2529E-02
4	CND 3	1	33.5180	33.2580	33.2630	33.34633	.2211E-01
5	CND 4	1	33.1100	33.1900	32.8600	33.05333	.2963E-01
6	GER 1	1	33.5080	33.4870	33.4810	33.49200	.2010E-03
7	GER 2	1	33.5430	33.6080	33.4580	33.53633	.5658E-02
8	GER 4	1	33.7670	33.4660	33.3490	33.52733	.4650E-01
9	GER 5	1	33.4820	33.5050	33.4340	33.47367	.1312E-02
10	GER 6	1	33.3880	33.4050	33.4660	33.41967	.1682E-02
11	GER 7	1	33.5150	33.4300	33.4450	33.46333	.2058E-02
12	JP 1	1	33.4070	33.3960	33.4520	33.41833	.8803E-03
13	JP 2	1	33.4230	33.2750	33.2200	33.30600	.1102E-01
14	JP 3	1	33.2480	33.3130	33.2880	33.28300	.1075E-02
15	JP 4	1	33.3000	33.3510	33.3030	33.31800	.8190E-03
16	JP 5	1	33.4270	33.4170	33.3880	33.41067	.4103E-03
17	JP 6	1	33.2910	33.3650	33.2930	33.31633	.1777E-02
18	PNG 1	1	33.5140	33.4310	33.4440	33.46300	.1993E-02
19	UK 1	1	33.4380	33.3350	33.5040	33.42567	.7254E-02
20	USA 1	1	33.5300	33.5000	33.5200	33.51667	.2333E-03

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-8

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	37.286
CHI-SQUARE(.95,19)	30.148

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

GER 4	C-CALC = .316	C-CRIT(3,20) = .270
CND 4	C-CALC = .294	C-CRIT(3,19) = .281
CND 3	C-CALC = .311	C-CRIT(3,18) = .293

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

CND 3	COCHRAN'S TEST FOR LABORATORY VARIANCE
CND 4	COCHRAN'S TEST FOR LABORATORY VARIANCE
GER 4	COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-8

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	16	.59091851E+00	.36932407E-01
WITHIN LABS	34	.97942667E-01	.28806667E-02
TOTAL	50	.68886118E+00	

REPEATABILITY VARIANCE	.28806667E-02
REPEATABILITY STD. DEV.	.05367184
BETWEEN-LABORATORIES VARIANCE	.11350580E-01
BETWEEN-LABORATORIES STD. DEV.	.10653910
REPEATABILITY	.15189131
PERMISSIBLE TOLERANCE BETWEEN LABS	.32006428
GRAND MEAN	33.39723529
VARIANCE OF THE GRAND MEAN	.72416484E-03

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-9

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	50.1450	50.1370	50.1580	50.14667	.1123E-03
2	CND 1	1	50.3820	50.3960	50.4140	50.39733	.2573E-03
3	CND 2	1	50.4570	50.4210	50.4690	50.44900	.6240E-03
4	CND 3	1	50.2800	50.5410	50.3950	50.40533	.1711E-01
5	CND 4	1	50.1800	50.3800	50.2000	50.28333	.1003E-01
6	GER 1	1	50.4640	50.4140	50.4510	50.44300	.6730E-03
7	GER 2	1	50.7560	50.8800	50.8460	50.82733	.4105E-02
8	GER 4	1	50.2670	50.4110	50.4010	50.35967	.6465E-02
9	GER 5	1	51.0020	50.8830	50.9280	50.93767	.3610E-02
10	GER 6	1	50.6220	50.6390	50.6350	50.63200	.7900E-04
11	GER 7	1	50.7560	50.8260	50.6710	50.75100	.6025E-02
12	JP 1	1	50.4350	50.4500	50.4270	50.43733	.1363E-03
13	JP 2	1	50.6060	50.5560	50.6060	50.58933	.8333E-03
14	JP 3	1	50.1400	50.1100	50.2050	50.15167	.2358E-02
15	JP 4	1	50.6940	50.6390	50.6870	50.67333	.8963E-03
16	JP 5	1	50.6660	50.6550	50.6580	50.65967	.3233E-04
17	JP 6	1	50.4850	50.4320	50.4900	50.46900	.1033E-02
18	PNG 1	1	50.5840	50.5600	50.6340	50.59267	.1425E-02
19	UK 1	1	50.6110	50.5880	50.5080	50.56900	.2923E-02
20	USA 1	1	50.7200	50.7400	50.6600	50.70667	.1733E-02

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-9

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	34.760
CHI-SQUARE(.95,19)	30.148

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

CND 3 C-CALC = .283 C-CRIT(3,20) = .270

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

CND 3 COCHRAN'S TEST FOR LABORATORY VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-9

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	18	.24460713E+01	.13589285E+00
WITHIN LABS	38	.86712668E-01	.22819123E-02
TOTAL	56	.25327839E+01	

REPEATABILITY VARIANCE	.22819123E-02
REPEATABILITY STD. DEV.	.04776937
BETWEEN-LABORATORIES VARIANCE	.44536979E-01
BETWEEN-LABORATORIES STD. DEV.	.21103786
REPEATABILITY	.13518731
PERMISSIBLE TOLERANCE BETWEEN LABS	.60483883
GRAND MEAN	50.53029825
VARIANCE OF THE GRAND MEAN	.23840851E-02

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-10A

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	AU 1	1	28.7770	28.7670	28.8120	28.78533	.5583E-03
2	CND 1	1	28.6000	28.6450	28.5800	28.60833	.1108E-02
3	CND 2	1	28.7010	28.6760	28.6760	28.68433	.2083E-03
4	CND 3	1	28.6170	28.5570	28.6720	28.61533	.3308E-02
5	CND 4	1	27.9500	28.2100	28.6400	28.26667	.1214E+00
6	GER 1	1	28.7000	28.7130	28.7360	28.71633	.3323E-03
7	GER 5	1	28.7890	28.7880	28.7950	28.79067	.1433E-04
8	GER 6	1	28.8980	28.8720	28.8600	28.87667	.3773E-03
9	JP 1	1	28.7650	28.7560	28.6900	28.73700	.1677E-02
10	JP 2	1	28.6890	28.6740	28.6770	28.68000	.6300E-04
11	JP 3	1	28.6110	28.6260	28.7060	28.64767	.2608E-02
12	JP 4	1	28.7860	28.7270	28.7020	28.73833	.1860E-02
13	JP 5	1	28.6020	28.6570	28.6660	28.64167	.1200E-02
14	JP 6	1	28.7230	28.6790	28.7370	28.71300	.9160E-03
15	PNG 1	1	28.7720	28.7900	28.7840	28.78200	.8400E-04
16	UK 1	1	28.7330	28.6630	28.7680	28.72133	.2858E-02

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-10A

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	66.128
CHI-SQUARE(.95,15)	25.000

VARIANCE IS INHOMOGENEOUS

COCHRAN'S TEST FOR LABORATORY VARIANCE (ALPHA=.05)

CND 4 C-CALC = .876 C-CRIT(3,16) = .319

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

CND 4 R = .672 D-CRIT(16) = .546

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

CND 4 DIXON'S TEST FOR MEANS AND COCHRAN'S TEST FOR VARIANCE

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-10A

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	14	.22724587E+00	.16231848E-01
WITHIN LABS	30	.34349333E-01	.11449778E-02
TOTAL	44	.26159520E+00	

REPEATABILITY VARIANCE	.11449778E-02
REPEATABILITY STD. DEV.	.03383752
BETWEEN-LABORATORIES VARIANCE	.50289566E-02
BETWEEN-LABORATORIES STD. DEV.	.07091514
REPEATABILITY	.09576018
PERMISSIBLE TOLERANCE BETWEEN LABS	.21180514
GRAND MEAN	28.71586667
VARIANCE OF THE GRAND MEAN	.36070773E-03

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-10

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	GER 1	1	28.7820	28.8030	28.8080	28.79767	.1903E-03
2	GER 2	1	28.6390	28.7140	28.7140	28.68900	.1875E-02
3	GER 3	1	28.4800	28.5700	28.3500	28.46667	.1223E-01
4	USA 1	1	28.4100	28.5100	28.5400	28.48667	.4633E-02

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-10

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	5.315
CHI-SQUARE(.95, 3)	7.817

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-1 COPPER IN COPPER CONC. - ELECTOGRAVIMETRIC/SULFIDE
SAMPLE: 85-10

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	3	.23164600E+00	.77215333E-01
WITHIN LABS	8	.37864000E-01	.47330000E-02
TOTAL	11	.26951000E+00	

REPEATABILITY VARIANCE	.47330000E-02
REPEATABILITY STD. DEV.	.06879680
BETWEEN-LABORATORIES VARIANCE	.24160778E-01
BETWEEN-LABORATORIES STD. DEV.	.15543738
REPEATABILITY	.19469495
PERMISSIBLE TOLERANCE BETWEEN LABS	.46092767
GRAND MEAN	28.61000000
VARIANCE OF THE GRAND MEAN	.64346111E-02

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-10

LABORATORY NO.	COUNTRY	BOTTLE NO.	ANALYTICAL RESULTS COPPER			LAB MEAN	LAB VARIANCE
1	GER 1	1	28.7570	28.7760	28.8010	28.77800	.4870E-03
2	GER 2	1	28.7390	28.7540	28.7850	28.75933	.5503E-03
3	USA 1	1	28.6000	28.5400	28.5600	28.56667	.9333E-03

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-10

BARTLETT'S TEST FOR HOMOGENEITY OF LABORATORY VARIANCE

CALCULATED STATISTIC	.205
CHI-SQUARE(.95, 2)	5.995

VARIANCE IS HOMOGENEOUS
(COCHRAN'S TEST NOT PERFORMED)

DIXON'S TEST FOR LABORATORY MEANS (ALPHA=.05)

NONE REJECTED

LIST OF LABORATORIES WHOSE RESULTS WERE NOT USED FOR ONE-WAY ANOVA

ALL RESULTS WERE USED EXCEPT INDIVIDUAL REPLICATES LISTED BELOW

LIST OF INDIVIDUAL OUTLIERS DETECTED BY DIXON'S TEST WITHIN-LABORATORIES

NONE REJECTED

ISO/TC 183/WG 4A/WG 4A-2 COPPER IN COPPER CONC. - ELECTROGRAVIMETRIC/HYDROXIDE
SAMPLE: 85-10

ONE-WAY ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	D.F.	SUM OF SQUARES	MEAN SQUARE
BETWEEN LABS	2	.82130667E-01	.41065333E-01
WITHIN LABS	6	.39413333E-02	.65688888E-03
TOTAL	8	.86072000E-01	

REPEATABILITY VARIANCE	.65688888E-03
REPEATABILITY STD. DEV.	.02562984
BETWEEN-LABORATORIES VARIANCE	.13469481E-01
BETWEEN-LABORATORIES STD. DEV.	.11605810
REPEATABILITY	.07253246
PERMISSIBLE TOLERANCE BETWEEN LABS	.33242474
GRAND MEAN	28.70133333
VARIANCE OF THE GRAND MEAN	.45628148E-02